FOOD FOR PLANTS

MYERS

COMPLIMENTS OF

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Chilean Nitrate Committee

25 MADISON AVENUE
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FOOD FOR PLANTS

New Edition
With Supplementary Notes

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PREFACE

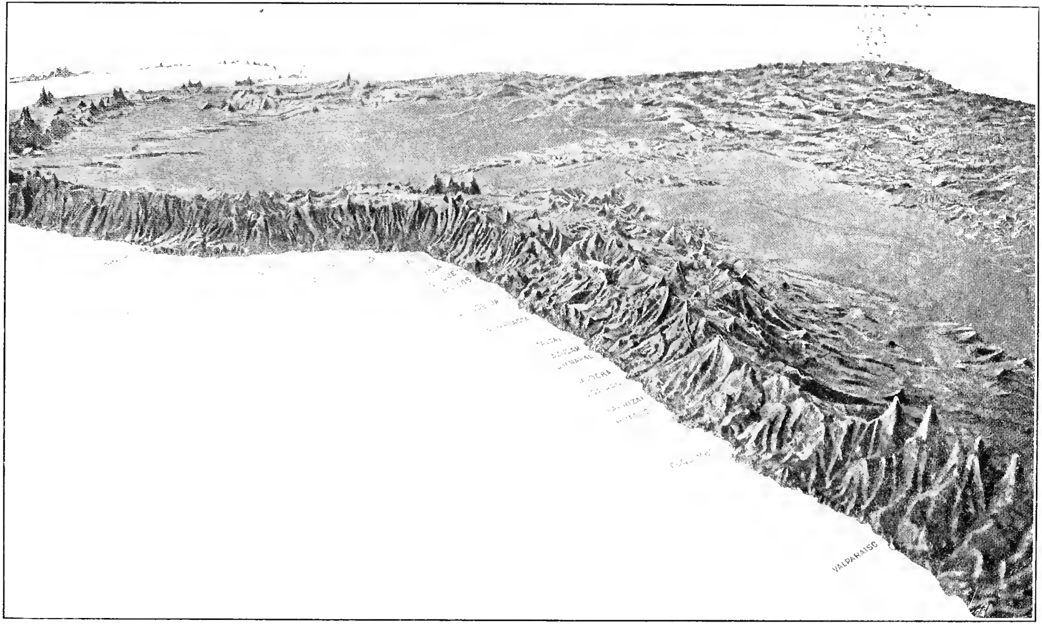
This is the eleventh edition of Food for Plants and, after repeated and extended revisions, the work has come to have a standard place in our American farm literature. It now includes results of original investigations and experiments on Highlands Experimental Farms.

The main purpose of all the within recorded experiments has been to demonstrate the value of Nitrate of Soda in the scheme of rational fertilization on a practical scale. The investigations have covered more particularly the questions of amount of Nitrate and other chemicals to be employed, time of application for most profitable results and practical methods for the preparation of grass lands and the harvesting of the hay crop.

These recorded experiments conclude the field work intended as demonstrations in farm practice of what may be accomplished by the rational use of Nitrate of Soda under average farm conditions in a typical dairy section of New York State.

The earlier results have appeared from time to time in former editions of "Food for Plants," "Grass Growing for Profit," and "Growing Timothy Hay for Market,"—all practical farm books of value, based on actual scientific and sound practical data. Studies having been made of methods of crop growing, from the preparation of the land to handling and marketing the crops, it is believed that these volumes have unique and unusual value.

WILLIAM S. MYERS.



Section of Relief Map of South America.—Chile in right foreground.

FOOD FOR PLANTS

Nitrate is a powerful plant tonic, food and energizer. It is not a stimulant in any sense of the word; a very small quantity does a very large amount of work.

We never recommend the use of Nitrate of Soda alone, except at the rate of not more than one hundred (100) pounds to the acre, when it may be used *without* other fertilizers. The phosphate fertilizers may generally be applied in connection with Nitrate of Soda at the rate of about two hundred (200) pounds to the acre. This rate will be found generally profitable for all crops. Nitrate is best applied as a Top-dressing in the spring soon after vegetation begins to grow. It will be found quite satisfactory also in its after-effect in perceptibly sweetening sour land.

Food Necessary for Plants.

It is well known that animals, and especially the young ones, must have all the food they can digest in order to properly develop and grow. This is equally true of plants. Plants will manage to live on very little food, but to grow, thrive and bear fruit they also require an abundance of food.

Why Nitrate is Indispensable.

The Food of Plants consists of a number of elements, including Nitrate, phosphate, lime and potash. Nearly always two of these are lacking in adequate quantities to produce crops, especially is Nitrate wanting in the vast majority of instances. In this case the normal growth and yield of the crop will be limited only by the quantity of *Nitrate* it can properly assimilate. There might be an abundant supply of all the other elements, but plants can never use other kinds of food without Nitrate.

Nitrate Nearly Always Deficient.

Nitrate Nitrogen is the food that is nearly always deficient. The question that presents itself to the farmer, gardener and fruit grower is, How can

I supply my plants with Nitrogen, phosphoric acid and potash, in the best forms and at the least expense? We will try to throw some light upon this question in the following pages. We will take first, Phosphoric Acid.

Phosphoric Acid. There are several sources of phosphoric acid, the principal being bones and rock phosphate. Of these, the rock phosphate is the cheapest source. A prevailing impression exists that superphosphate made from rock phosphate is not as good as that made from bones. It has been shown by many experiments that this idea is entirely without foundation. What the plants want is available phosphoric acid, and it makes little or no difference from what source it is derived.

The largest deposits of rock phosphates exist in South Carolina, Florida and Tennessee. These beds of phosphate are supposed to be composed of the petrified bones and excrements of extinct animals. When this substance is ground and mixed with a sufficient quantity of sulphuric acid, the larger part of the phosphoric acid which it contains becomes soluble in water, and hence available as plant food. This fact was one of the greatest agricultural discoveries of the age.

When the rock phosphate is thus treated with sulphuric acid, it becomes what is commercially known as superphosphate, or acid phosphate. The same is true if ground bone is treated in the same way. Good superphosphate, or acid phosphate, contains 14 per cent. of soluble phosphoric acid.

Potashes. The best sources of potash are sulphate of potash and unleached wood ashes, which latter contain from 3 to 5 per cent. of potash in the form of carbonate. They also contain from 1 to 2½ per cent. of phosphoric acid. They are worth usually, as plant food, from $7.00 to $11.00 per ton, not to mention the valuable lime they contain.

Nitrate. Nitrate is the most important and effective element of plant food, and at the same time, as stated, is the one that is generally deficient in the soil.

Lands must have meals, that is, food cooked for them in advance. The sun will help do this cooking, as its heat and light promote nitration which is really a process of cooking and also pre-digestion. When the plant food is cooked and prepared for use it is Nitrate, hence Nitrate of Soda is in a class by itself, different from all other plant foods.

There are a great many sources of Nitrogen, such as dried fish, cotton-seed meal, dried blood, and tankage. But none of these furnish Nitrogen in the Nitrate form in which it is taken up by plants. This can only be furnished to plants in the form of Nitrate of Soda. Nitrogen applied in any other form must be first converted into Nitrate before it can be used by plants at all.

Nitrate of Soda contains the Nitrogen that is necessary for the growth of plants, and is the best form in which to furnish Nitrogen to plants. When we say the *best* form we mean as well the best *practical* form. Nitrate of Soda not only furnishes Nitrogen in its most available form, but it furnishes it at a lower price than any other source, because 100 per cent. of it or all is available.

No other form containing so much available plant food is also capable of unlocking the latent potash in the soil.

How Nitrate Benefits the Farmer.

What Nitrate Looks Like; Its Chemical Properties.

Nitrate of Soda, from the standpoint of the agricultural chemist, is a substance formed by the union of nitric oxide and soda. In appearance it resembles coarse salt. In agriculture, it is valuable chiefly for its active Nitrogen, although it is also a soil sweetener and is frequently capable of rendering available potash in the soil.

What it is in Agriculture.

Commercially pure Nitrate contains about 15 per cent. of Nitrogen, equivalent to 18.25 per cent. of Ammonia, or 300 pounds of Nitrogen to the ton.

Where it is Found.

Nitrate of Soda is found in vast quantities in Chile. The beds of Nitrate, or "Caliche," as it is called in Chile before it is refined, are several thousand feet above the sea, on a desert plain extending for seventy-five miles north and south, and about twenty miles wide, in a rainless region. The surface of the desert is covered with earth or rock, called "costra," which varies from three to ten or more feet in thickness. Under this is found the "Caliche," or crude Nitrate. The layer of "Caliche" is sometimes eight or ten feet thick, but averages about three feet. This "Caliche" contains on the average about 50 per cent. of pure Nitrate of Soda.

There is ample Nitrate now in sight to last, it is calculated, upwards of two hundred years.

Method of Refining.

The "Caliche" is refined by boiling in water to dissolve the Nitrate. This hot water is then run off and allowed to cool in tanks, when the Nitrate forms in crystals like common salt. The Nitrate is then placed in bags of a little over two hundred pounds each and shipped to all parts of the world. How these beds of Nitrate were formed has been the subject of much speculation. The generally accepted theory is, that they were formed by the gradual decomposition and natural manurial fermentation of marine animal and vegetable matter, which contains a considerable amount of Nitrogen. The process of refining is an expensive one.

The same wise Providence that stored up the coal in the mountains of Pennsylvania to furnish fuel for people when their supply of wood had become exhausted, preserved this vast quantity of Nitrate of Soda in the rainless region of Chile, to be used to furnish crops with the necessary Nitrate when the natural supply in the soil had become deficient.

Its Uses.

The enormous explosive industry of this country could not be conducted without Nitrate of Soda, and glass works are dependent upon it. In fact, glass works and powder works usually have Nitrate on hand.

Nitrate of Soda has a special bearing on the progress of modern agriculture, being the most nutritious form of Nitrogenous or ammoniate plant food. While the action of micro-organisms with certain crops (legumes) combines and makes effective use of the inert Nitrogen of the atmosphere, such action is far too slow and uncertain for all the requirements of modern agriculture, for it is not available for use for a whole year or even longer. The rapid exhaustion of combined Nitrogen has several times been noticed by eminent scientific men, with reference to food famine, because of a lack of the needful Nitrogenous plant food.

Its Position in Modern Agriculture.

It has been estimated under the present methods of cropping the rich lands of our Western States, that for every pound of Nitrogen actually used to make a wheat crop, four to five pounds are utterly wasted. In other words, our pioneer agriculture has proceeded as though fertility capital could be drawn upon forever.

Wasteful Methods by our Pioneer Farmers.

This injudicious waste is already reducing the yield of many of the best lands, rendering the use of at least a small application per acre of Nitrate both profitable and necessary. The agricultural value of Nitrate of Soda has had the attention of the foremost agricultural and scientific specialists of the world, including such men as Dr. Wagner and Professor Maercker, of Germany; Lawes and Gilbert, Sir William Crookes, Dr. Dyer, Dr. Hall and Dr. Voelcker, in England; Professors Grandeau, Cassarini, Migneaux, and Cadoret, in France; Professors Bernardo and Alino, in Spain; and Drs. Voorhees, Brooks, Duggar, Ross, Patterson, Hilgard and Garcia in America. The results obtained by these officials may be summarized as follows:

Eminent Scientists the World Over Well Acquainted with the Great Value of Nitrate.

1. Nitrate of Soda acts very beneficially and with great certainty upon all straw-growing plants.

2. It is of special value for forcing the rapid development and early maturity of most garden crops.

3. It is of great importance in the production of

sugar beets, potatoes, hops, fodder crops, fiber plants, and tobacco.

4. It is exceedingly valuable in developing and maintaining meadow grass and pasture lands.

5. In the early stages of development it produces favorable results upon peas, vetches, lupines, clover, and alfalfa.

6. It has been applied with much advantage to various kinds of berries, bush fruits, vineyards, orchards and nursery stock, and small fruits generally.

7. It provides the means in the hands of the farmer, for energizing his crops so that they may better withstand the ravages of drought, or the onslaughts of plant diseases or insect pests, such as boll weevil, and others.

Top-Dressing.

8. It may be used as a surface application to the soil, from time to time, as the plants indicate a need of it by their color and growth.

9. It is immediately available, and under favorable conditions its effect upon many crops may be noticed within a few days after its application.

10. It may be used either as a special fertilizer, or as a supplemental fertilizer.

11. The best results are obtained from its application when the soil contains ample supplies of available phosphoric acid and potash. It should always be remembered that it furnishes the one most expensive and necessary element of plant food, namely, Nitrogen, and of the various commercial forms of Nitrogen, Nitrate is the cheapest.

12. Its uniform action seems to be to energize the capacity of the plant for developing growth. Its action is characterized by imparting to the plant a deep green, healthy appearance, and by also causing it to grow rapidly and to put out numbers of new shoots.

13. The immediate effect of an application of Nitrate of Soda, therefore, is to develop a much larger plant growth and its skillful application must be relied upon to secure the largest yields of fruits and grain.

14. Under favorable conditions of moisture and

cultivation, these effects may be confidently anticipated upon all kinds of soils.

15. All of the plant food contained in Nitrate of Soda is available and existing in a highly soluble form. The farmer should understand that it is not economical to apply more of it than can be utilized by the crop; one of the most valuable qualities of this fertilizer being that it need not lie dormant in the soil from one season to the next.

16. The best results are secured when it is applied during the early growing period of the plant. If applied too late in the development of the plant, it has a tendency to protract its growing period and to delay the ripening of the fruit, as the energies of the plant are immediately concentrated upon developing its growth, after a liberal application of Nitrate of Soda. This is true with some exceptions.

17. The farmer must not expect it to excuse him from applying proper principles of land drainage, or cultivation of the soil, nor should Nitrate of Soda be used in excessive quantities too close to the plants that are fertilized with it. For most agricultural crops, an application of one hundred pounds to the acre is sufficient when it is used alone.

18. It may be applied to either agricultural or garden lands by sowing it broadcast upon the land, or by means of any fertilizer-distributing machine in use. If applied in the dry state, in order to insure uniform distribution, a convenient method is to mix it with twice its weight of air-slacked lime, land plaster, or even with dry loam or sand before applying it. It can be applied to the surface, and without cultivation will be absorbed by the soil, or it may be cultivated into the soil by some light agricultural implement, such as a harrow, weeder, cultivator or horse hoe. The capillary movement of the soil waters will distribute it in the soil, and the capillary attraction of the soil when in good tilth will retain it safely until the plant uses it.

Accepting the conclusions of these scientific men, the use of Nitrate of Soda in agriculture ought to increase proportionately to the dissemination of the knowledge of its usefulness among our farmers. An

Its Use is Increasing.

increase in the consumption of Nitrate among growers of tobacco, fiber plants, sugar beets, the hop, grape, grass and small fruits, has been most notable of late. The element of plant food first exhausted in soils is Nitrogen, and in many cases a marked increase in crop is obtained through Top-Dressing of Nitrate alone. "Complete" fertilizers are generally rather low in Nitrogen, and most expensive, and Nitrate may be wisely used to supplement them, as it is practically the cheapest form of plant food Nitrogen.

"Complete Fertilizers" and "Phosphates" the Most Expensive Plant Food.

By "complete fertilizers," is meant fertilizers containing Nitrogen, phosphoric acid and potash. These fertilizers are often called "phosphates," and people have fallen into the habit of calling any commercial fertilizer a "phosphate," whether it contains phosphate or not. Many so-called "complete fertilizers" are merely low grade acid phosphates with insignificant amounts of the other essential plant foods. They are unprofitable and ill balanced rations for all crops.

The value of these "phosphates," no matter how high sounding their names, is usually mostly in phosphoric acid and potash.

The Nitrogen contained in these "complete fertilizers" is often in a form that is neither available nor useful to the plants until it has become converted into Nitrate. The time required to do this varies from a few days to a few years, according to the temperature of the soil and the kind and condition of the material used.

Statistics gathered by the Experiment Stations show that many millions of dollars are spent annually in the United States for "complete fertilizers." Considering that the average "complete fertilizer" costs 25 per cent. more than it is worth, it is evident that farmers pay immensely more for their fertilizers than they get value in return. And this state of things is the same all over the country. The farmers of this country are paying out many millions of dollars annually to the manufacturers of "complete fertilizers," which they could very easily save by the exercise of a little care and foresight.

How to Save Money on Fertilizers.

Would you not think a man very unwise who should buy somebody's "Complete Prepared Food," at a high price, when he wanted feed for his horses, instead of going into the market and buying corn, oats and hay, at market prices?

The "Complete Prepared Food" would probably be composed of corn, oats and hay mixed together, and the price would be, perhaps, twice as much as the corn, oats and hay would cost separately. It is the same with plant food. It is always more economical to buy the different fertilizing materials and mix them at home than to purchase "complete" fertilizers as they are often called. Some do not wish to take pains to get good materials and mix them, and prefer to purchase the "complete" fertilizers. If this be done, special attention should be given to ascertaining in what form the Nitrogen exists. Many of the manufacturers do not tell this, but the Experiment Stations analyze all the fertilizers sold in their respective States and publish the results in bulletins, which are sent free to anyone asking for them. These analyses should show in what form the Nitrogen is. The "complete fertilizers" that contain the most Nitrogen in the form of Nitrate are the ones to use, and the ones which do not contain Nitrate or which do not give information on this vital point should not be purchased. If you have on hand a "complete fertilizer" containing a small percentage of Nitrogen, and only in organic form, such as cottonseed, "tankage," etc., it will be of great advantage to use one hundred pounds per acre of Nitrate of Soda in addition to this fertilizer. No fertilizer is really complete without Nitrate of Soda.

What Fertilizers to Buy.

Are the Farmers of Little Europe More Intelligent Than Those of America?

It certainly seems so. The English and European farmers instead of buying their Nitrogen in complete fertilizers and paying over 25 cents per pound for it, use annually over eight hundred thousand (800,000) tons of Nitrate of Soda as a fertilizer, while yet only a few thousands of American farmers are using it at a cost generally of less than 20 cents per pound.

American farmers, gardeners and fruit growers are supposed to be ready to "catch on" to a good thing. And as soon as our Agricultural Press let them know the facts in regard to the great value of Nitrate of Soda as a Fertilizer our farmers will not be slow to use it. The reason why so little is said about Nitrate of Soda is simply owing to the fact that there is "no money in it for the trade." It is an article that everybody can sell, and consequently no one can afford to advertise it. The real friends of agriculture, however, will be pleased to know that there is a decided increase in the demand for Nitrate of Soda in this country. As soon as the farmers demand it, the dealers in fertilizers will be glad to keep the Nitrate for sale, and sooner or later will advertise it. In the mean time, if your agricultural paper does not tell you about Nitrate of Soda and how to use it, take a paper that keeps up with the science and practice of the age.

It is now known that the Nitrogen in organic matter of soil or manure is slowly converted into the Nitrate form by a minute organism. This cannot grow if the soil be too cold, or too wet, or too dry, or in a sour soil. As a general rule, soils must be kept sweet and the other conditions necessary for the conversion of the Nitrogen into the Nitrate form are warm weather and a moist soil in good physical condition.

In the early spring the soil is too wet and too cold for the change to take place. We must wait for warm weather. But the gardener does not want to wait. He makes his profits largely on his early crops Guided only by experience and tradition, he fills his land with manure, and even then he gets only a moderate crop the first year. He puts on 75 tons more manure the next year, and gets a better crop. And he may continue putting on manure till the soil is as rich in Nitrogen as the manure itself, and even then he must keep on manuring or he fails to get a good early crop.

Why? The Nitrogen of the soil, or of roots of plants, or dung, is retained in the soil in a comparatively inert condition. There is little or no loss. But when it is slowly converted into Nitrate during warm weather, the plants take it up and grow rapidly.

How, then, is the market gardener to get the Nitrate absolutely necessary for the growth of his early plants? He may get it, as before stated, from an excessive and continuous use of stable manure, but even then he fails to get it in sufficient quantity.

One thousand pounds of Nitrate of Soda, will furnish more Nitrogen to the plants early in the spring than the gardener can get from 100 tons of well-rotted stable manure. The stable manure may help furnish Nitrate for his later crops, but for his early crops the gardener who fails to use Nitrate of Soda is blind to his own interests.

On What Crops Nitrate Should be used.

A given quantity of Nitrate will produce a given amount of plant substance. A ton of wheat, straw and grain together, contain about 1,500 pounds of dry matter, of which 25 pounds is Nitrogen. To produce a ton of wheat and straw together would require, therefore, 170 pounds of Nitrate of Soda, in which quantity there is 25 pounds of Nitrogen.

A ton of cabbage, on the other hand, contains about 4½ pounds of Nitrogen. To produce a ton of cabbage, therefore, would require 30 pounds of Nitrate of Soda.

Fertilizers for Vegetables and Small Fruits.

There are no crops on which it is more profitable to use fertilizers than on vegetables and small fruits, provided they are used rightly. Failures with chemical fertilizers are caused usually by lack of knowledge. There is no doubt but that stable manure is valuable as a fertilizer, and in some cases may be indispensable, but at the same time the *quantities* necessary to produce good results could be greatly reduced by using chemical fertilizers to supply plant *food* and only enough manure to give lightness and add humus to the soil.

What Fertilizers to Use for Garden Crops.

For crops like cabbage and beets, that it is desirable to force to rapid maturity, the kind of plant food, especially of Nitrogen, is of the greatest importance. Many fertilizers sold for this purpose have all the Nitrogen they contain in insoluble and unavailable form, so that it requires a considerable time for the plants to get it. Another fault is that they do not contain nearly enough Nitrogen. Stable manure contains on the average in one ton 10 pounds Nitrogen, 10 pounds potash, and only 5 pounds phosphoric acid, while the average "complete" fertilizer contains more than *twice* as much phosphoric acid as Nitrogen, a most unnatural and unprofitable ration. A ratio of 2 Nitrogen, 4 potash, and 10 of phosphoric acid, is frequent in many of the so-called "complete fertilizers," which are really incomplete and unbalanced as well. A fertilizer for quick-growing vegetables should contain as much Nitrogen as phosphoric acid, and at least half this Nitrogen should be in the form of Nitrate, which is the only immediately available plant food.

Comparative Availability of Nitrogen in Various Forms.

Some interesting and valuable experiments were made at the Connecticut Experiment Station, to ascertain how much of the Nitrogen contained in such materials as dried blood, tankage, dry fish, and cotton-seed meal, is available for plants.

The experiments were made with corn, and it was found that when the same quantity of Nitrogen was applied in the various forms the crop increased over that where no Nitrogen was applied, as shown in the following table:

Increase of Crop from Same Quantity of Nitrogen from Different Sources.

Sources of Nitrogen.	Relative Crop Increase.
Nitrate of Soda	100
Dried Blood	73
Cotton-seed Meal	72
Dry Fish	70
Tankage	62
Linseed Meal	78

The above table shows some interesting facts. It is evident that only about three-fourths as much of the Nitrogen in dried blood or cotton-seed meal as in Nitrate of Soda is available the first season. The Nitrogen in tankage is even less available, only a little over half being used by the crop.

These experiments were made with corn, which grows for a long period when the ground is warm and the conditions most favorable to render the Nitrogen in organic substances available, and yet only part of it could be used by the crop.

When it is considered that Nitrogen in the form of Nitrate of Soda can be bought for as little or less per pound than in almost any other form, the advantage and economy of purchasing and using this form is very apparent.

Nitration as studied by means of the drainage water of 6 plots of land, each 300 square yards in area, during 4 years, shows that the loss of Nitrogen in the drainage water was very small and practically negligible. Even when Nitrogen was applied in the spring the losses were not large unless heavy rains occurred at the time. The Nitrogen is apparently rapidly taken up by the young growing plants at this season of the year and only a small portion is free to pass into the drainage. The greatest losses may occur in the fall, when the soil is bare and heavy rains occur, the Nitrates having accumulated in large quantities during the warmer period of the year. Large losses at this season are, however, prevented by the growing of cover crops.

Chile's Supply of Nitrate.

Investigation Proves It Sufficient, in all Likelihood to Last Several Centuries.

A good deal has been said in this country and in Europe about the probability of the Nitrate beds of Chile being exhausted within twenty to twenty-five years. The matter has been the subject of a native government investigation with the result that the investigators report enough to last for several centuries yet.

Of interest in connection with the report of a new process for the cheap commercial extraction of Nitrogen from the air, for use in making fertilizers, is a recent (Chilean) government report on the Chilean Nitrate beds. It is estimated that the state still possesses nearly 5,000,000 acres of Nitrate grounds, which contain about 1,000,000,000,000 pounds of Nitrate. Taking half this figure as the total available supply, and assuming an annual export of 8,000,000,000 pounds, which is more than twice the amount ever sent out of the country in any one year, it would require upwards of 125 years to exhaust the beds. If to these government beds there be added those belonging to private persons, the final exhaustion of the supply will not be for another two or three hundred years. The reported imminency of the failure of the Chile beds has been one of the reasons urged for the development of an artificial process of manufacture, up to this time a failure commercially.

So many sensational statements have been made of late which would lead one to suppose that the exhaustion of the supplies of Chilean Nitrate is imminent, that I am asking you to help dissipate the prevailing opinion that very little Nitrate of Soda is now left in Chile for fertilizer or other purposes.

First of all, there is a vast amount of unsurveyed Nitrate ground on the Chilean pampas that is, nevertheless, known to contain immense quantities of Nitrate of Soda.

Second, grounds already surveyed still contain enormous quantities of Nitrate. There are probably, in round numbers, one billion tons of Nitrate in the deposits of Chile, and, without doubt, large supplies also exist on lands now but incompletely prospected. The surveyed and certified tonnage opened up at the present time ready for extracting is fully 250,000,000 tons.

The probable life of the surveyed deposits is upwards of 200 years, even allowing for a steadily increasing annual rate of consumption.

Moreover, there remains the interesting question as to whether by the end of the ensuing century we may not find that nature shall have by that time manufactured an immense additional amount of Chilean Nitrate for the uses of the world.

Sir William Crookes' prophecy that the world would starve for lack of bread as soon as the Chilean Nitrate supplies were exhausted has for some years led the chemical public to believe that a wheat famine was in sight, but that time is so far distant that no one living to-day need have misgivings on the subject.

Hints for Right Use of Nitrate.

The points to be observed in the use of Nitrate of Soda are: Avoid an excess; do not sprinkle the wet foliage with dry Nitrate; and in general Nitrate must not be allowed to come in contact with the stems or leaves of plants. Nitrate of Soda is immediately available as plant food. Applications of Nitrate of Soda may be made at the rate of 100 pounds per acre at intervals of two or three weeks during the growing season.

How to Mix and Apply Nitrate of Soda and Other Fertilizers.

Nitrate of Soda comes from South America in 224-pound bags, and is usually thus sold. The Nitrate looks much like coarse salt. The lumps should be broken, which can easily be done by turning the Nitrate out on the barn floor and breaking them with the back of a spade. The Nitrate should then be run through a sieve with a mesh not larger than three-eighths inch. It will then be ready for use.

When fertilizers are to be mixed together, pour the right quantity of each in a pile on the floor and turn them over two or three times with a shovel until they are thoroughly mixed. It is a good plan to run the whole through a sieve, which will completely mix the fertilizers. The mixing should not be done more than a week before the fertilizers are to be used, as the mixture may attract moisture and get hard if left too long after mixing. In Europe small hand machines are used by farmers for grinding and mixing, and cost about twenty-five dollars. They are also in use in America.

How to Apply Phosphatic Fertilizers.

In applying fertilizers it should be remembered that any form of phosphoric acid, such as acid phosphate, dissolved bone-black or bone meal is only partially soluble, and will not circulate in the soil. These fertilizers should therefore be evenly distributed over the soil and well mixed with it. This is usually best done by applying broadcast before sowing the seed and before the ground is thoroughly prepared. In this way it gets well mixed with the soil.

Nitrate of Soda, on the other hand, will diffuse itself rapidly and thoroughly throughout the soil wherever there is enough moisture to dissolve it. It can therefore be applied by scattering on the surface of the ground as soon as the plants are up. This latter method, called "Top-Dressing," is usually the best.

How and Where to Buy Fertilizing Materials.

Since Nitrate of Soda and salts of potash are brought to this country by sea, and phosphate is usually transported from the mines in vessels, all these materials, as a rule, can be purchased at the seaports cheaper than in the interior. New York is the largest market for these materials, but Philadelphia, Baltimore, Charleston, Savannah, Mobile, New Orleans, Galveston, and San Francisco are also ports of entry.

Lower prices can be obtained by buying fertilizing materials in car-load lots. A car-load is not less than ten tons. If you cannot use a car-load yourself, get your neighbors to join with you. Much money can often be saved in this way.

In buying always consider the percentage of available fertility.

The various "brands" of fertilizers are composed, for the most part, of substances such as plaster, fillers, superphosphate, etc., which can be manufactured for much less than the prices charged for these substances in so-called "complete fertilizers." The freight charges on these are just as high as on the essential constituents, so that every extra hundred weight of "filler" is useless expense.

Cost of Transportation of Fertilizers.

A striking illustration of the difference in the cost of transportation by four different ways is given below:

Cost of Transportation per Ton.

Horse power, 5 miles	$1.25
Electric power, 25 miles	1.25
Steam cars, 250 miles	1.25
Steamships on the lakes, 1,000 miles	1.25

RETABULATION SHOWS THAT:

$1.25 WILL HAUL A TON—

5 miles on a common road,
12½ to 15 miles on a well-made stone road,
25 miles on a trolley road,
250 miles on a steam railway,
1,000 miles on a steamship.

It will be seen that the same amount of money it takes to haul a given amount of produce five miles on a public highway of the United States will pay the freight for 250 miles on a railroad and 1,000 miles on a steamship line on the lakes. This is too great a difference, as will be admitted by all, and when we think of the fact that the railroad companies are ever at work repairing and improving their highways while the farmer is apparently so little awake to his own interests in regard to furnishing himself with better roads, we wonder why it is. The lesson seems plain and clear, and, as farmers, let us continue to aid the good road movement throughout the country.

Nitrate of Soda is essentially a seaboard article; supplies at interior points are not always available, hence the ports of entry are indicated to you as the best sources of supply.

It has been the custom of the railroad companies to discriminate heavily against Nitrate of Soda by charging prohibitory chemical rates, and it is hoped by correctly designating the material, the discrimination will not be practiced.

Farm newspapers generally, are quite willing to publish wholesale quotations on all those things which the farmer has to sell, and they have not, as a rule, published wholesale quotations on those articles which he has to buy. Among the latter, agricultural chemicals occupy a position of prime importance, not only as to actual effect on farm prosperity, but as to the actual amount of cash which the farmer has to spend, for his produce comes out of the soil and its amount and quality is determined by the character of the chemicals he puts in it. Agricultural journals generally, which profess to be friends of the farmer, should make a continued effort in the direction of enhancing his purchasing power, by endeavoring to make him more prosperous. This cannot be done under old conditions of helping to make him, at the outset, pay such a large bonus for agricultural chemicals under one pretext or another.

The improvement of our water-ways, so long urged by us, seems at last to be in sight; and farm chemicals at lower rates may ultimately be expected, even at interior points.

You should buy your plant food in the best and cheapest forms, and feed it to the plants as they require it. You can buy available Nitrogen in Nitrate of Soda for about 18 cents per pound. In so-called "complete fertilizers," Nitrogen costs from 20 to 30 cents per pound, and even then only part of it is likely to be available. Nitrate of Soda is the best form in which to buy Available Nitrogen,—cheapest also because quickest acting.

One would not think of buying raw, unground phosphate rock for phosphatic plant food; why, then, should one ever seriously consider buying the most expensive plant food, viz.: Nitrogen in the raw and indigestible forms, which many manufacturers and dealers endeavor to foist on our farmers.

Abstract of United States Experiment Station Record.

From Massachusetts Station Report, 1905.

Availability Tests.

Mixed oats and peas were grown this year in connection with comparative tests of different sources of

Nitrogen, and on the basis of yields secured the materials ranked as follows: Nitrate of Soda, dried blood, sulphate of ammonia, and barnyard manure. Based on the increase of all the crops since the beginning of the experiments the relative rank was: Nitrate of Soda 100, dried blood 68.72, sulphate of ammonia 60.78, barnyard manure 80.58.

On the grass lands receiving different fertilizer treatment in rotation the average yield of hay was at the rate of 4,840 lbs. per acre for all 3 systems of manuring. The average yield in this test from 1893 to 1905, inclusive, was 6,479 lbs. An application of Nitrate of Soda, after harvesting the first crop of grass, gave but a relatively small increase in yield, but, in one instance, where applied at the rate of 150 lbs. per acre an increase of nearly 1 ton of rowen, or considerably more than sufficient to pay the cost of the fertilizer, was obtained. The results in determining the relative value for garden crops with fertilizers supplying respectively Nitrogen and potash, when used with manure, show that on the basis of total crops produced the standing of the different Nitrogen fertilizers is, for the early crops, Nitrate of Soda 100, dried blood 95.67, sulphate of ammonia 63.08, and for late crops Nitrate of Soda 100, dried blood 98.77, sulphate of ammonia 79.52. For 15 years the relative standing of the fertilizers supplying potash is, for early crops, sulphate of potash 100, muriate of potash 94.66, and for late crops, sulphate of potash 97.09, and muriate of potash 100.

From United States Experiment Station Record, November, 1906.

The results of plot experiments with wheat here reported indicate that the Nitrate alone in 2 applications was more effective than a mixture of Nitrate of Soda and sulphate of ammonia.

How to Use Chemical Fertilizers to Advantage.

How all Crops Grow.

Crops grow only in consequence of the food placed at their disposal; practically, the plant foods consist of certain combinations or mixtures of Nitrogen, phosphoric acid and potash. All soils contain some of these plant foods, and few soils contain them in very large quantities. Fortunately for the permanence of agriculture, nature does not permit these natural supplies to be drawn upon freely, and any attempt to over-force the soil by injudicious farming is met by a temporary exhaustion. The so-called "artificial manures" are simply chemical or organic substances which contain one or more of the three elements of plant food.

As to the Nature of Chemical Manures.

Nitrate as a Top-Dressing for Grains, Grasses, Root-Crops, Pastures, Soiling Crops.

The use of Nitrate of Soda is well known as a top-dressing for small grains. Wheat on strong clay will repay an application of 100 pounds of Nitrate per acre, even if already heavily fertilized. For Roots 100 pounds at seed time and 100 pounds after thinning is found profitable.

How Nitrate Increases Wheat Crops.

The form of Nitrogen most active as plant food is the nitrated form, namely: Nitrate of Soda. All other Nitrogens must be converted into this form before they can be used as food by plants. Sir John Lawes wisely remarks: "When we consider that the application of a few pounds of Nitrogen in Nitrate of Soda to a soil which contains several thousand pounds of Nitrogen in its organic form, is capable of increasing the crop from 14 to 40 or even 50 bushels of wheat per acre, I think it must be apparent to all that we have very convincing evidence of the value of Nitrate." The Nitrogen of Nitrate of Soda is immediately available as plant food, and it should therefore be applied only when plants are ready to use it. By such a ready supply of available plant food, young plants are able to establish such a vigor of growth that they can much better resist disease, and the attacks of insects and parasites. The famous experiments of Lawes and Gilbert at Rothamsted have demonstrated that cereals utilize more than three times as much of the Nitrogen in Nitrate of Soda as of the Nitrogen contained in farmyard manure; in practice, four and one-half tons of farmyard manure supply only as much available plant food as 100 pounds of Nitrate of Soda.

Nitrate Compared with Farmyard Manure

Catch-Crops.

Catch-crops are recommended to prevent losses of available plant food after crops are removed. Rape, Italian rye grass, rye, thousand-headed kale and clovers are suitable. All these should be top-dressed with from 100 to 200 pounds per acre of Nitrate of Soda, depending upon the exhaustion of the soil. In the remarks on the use of Nitrate in this sketch, we have taken it for granted that our readers fully understand that in all cases where Nitrate has been recommended in large amounts, potash and phosphates may be used also unless the soil already contains ample supplies of both.

Nitrate of Soda Niter in Fertilizing.

(Bulletin 24, California State Mining Bureau.)

By Dr. Gilbert E. Bailey.

All plants require light, air, heat, water, cultivation, and a fertile soil. Every crop removes from the soil a portion of the plant food contained therein, and continuous cropping will, in time, exhaust the richest soil, unless the nutritive elements are restored; therefore, the truly economical farmer will feed the growing plant or tree with a generous hand. The literature on this subject is so scattered as to be difficult of access to the general reader, and the following notes are added in order to give some general idea of the value of Nitrate of Soda in fertilizing.

The most important material used to supply Nitrogen, in the composition of commercial fertilizers is Nitrate of Soda. Nitrate of Soda is particularly adapted for Top-Dressing during the growing season, and is the quickest acting of all the Nitrogenous fertilizers.

Dried blood, tankage, azotine, fish scrap, castor pomace, and cotton-seed meal represent fertilizers where the Nitrogen is only slowly available, and they must be applied in the fall so as to be decomposed and available for the following season. Nitrogen in the form of Nitrate of Soda is available during the growing and fruiting season, possessing, therefore, a decided advantage over all other Nitrogen plant-foods.

The following table shows the number of pounds of Nitrogen removed in one year from one acre by the crop specified:

	Crop.		Nitrogen.
Wheat	35	bushels.	59 lbs.
Rye	30	bushels.	51 lbs.
Barley	40	bushels.	46 lbs.
Oats	60	bushels.	55 lbs.
Corn	50	bushels.	67 lbs.
Buckwheat	30	bushels.	35 lbs.
Potatoes	200	bushels.	46 lbs.
Sugar Beets	15½	tons.	69 lbs.
Mangel-wurzel	22	tons.	150 lbs.
Meadow hay	2½	tons, dry.	83 lbs.
Green corn	11½	tons.	85 lbs.
Alfalfa	8	tons.	113 lbs.
Hops	600	lbs. seed.	84 lbs.
Tobacco	1,600	lbs.	89 lbs.
Grapes	2	tons.	32 lbs.
Cabbage	31	tons.	150 lbs.
Oranges	10	tons.	24 lbs.

In the following tables the quantities given are merely selected to express the average equivalent amount of Nitrate of Soda which may be removed by the average crops taken from any soil in one season. It is not intended to thereby recommend that the same amount of Nitrate of Soda should be put on the soil each season, but merely to show the great rate at which soil exhaustion of Nitrates proceeds.

	Fertilizer Nitrate of Soda.	Nitrogen in pounds.		Fertilizer Nitrate of Soda.	Nitrogen in pounds.
	Per acre	*Per cent.*		*Per acre.*	*Per cent.*
Artichokes...	500 lbs.	18	Mint.........	700 lbs.	28
Asparagus...	500	22.5	Oats.........	100	10
Barley.......	300	5		*Per tree.*	
Beans.......	100	14	Oranges......	3	4
Beets, sugar.	300	60		*Per acre.*	
Buckwheat..	100	9.0	Peas.........	200	20
Cabbage.....	500	60.0	Potatoes, Irish	150	21
Carrots......	300	15.0	Radishes......	240	15
Celery.......	700	18.0	Rape.........	2,800	24
Corn........	150	13.75	Raspberry....	300	21
Cotton......	100	18.0	Rice..........	300	13.5
Cranberry...	200	12.0	Squash.......	200	64.0
Currants.....	300	16.5	Strawberry....	300	45.0
Egg-Plant....	400	80.0	Sunflower.....	300	60.0
Hemp.......	200	44.00	Tobacco......	600	54.00
Hops........	400	30.00	Tomatoes.....	1,400	36.00
Horseradish..	300	24	Trees, general.	300	8.00
Lettuce......	300	50.0	Turnips.......	200	2.5
Melons......	300	36.0	Wheat........	100	3

Chemical fertilizers are used freely by the fruit growers of California, and their use among the farmers is steadily increasing. One reason why they are not used more extensively is that they have to be imported from the East. It is also a fact that the total amount now used is only a small percentage of what should be employed. Everyone will admit that the use of fertilizers in this State is small compared with their use in Germany, where they are employed more extensively than by any other nation.

Soiling Crops.

"Soiling" is rapidly becoming recognized as the most economical method of stock feeding; practically, soiling means keeping stock confined, and using green-cut food. It is now known to be much more economical than pasturing, not only that more stock can be kept per acre, but the feeding results are more profitable. The crops chiefly used are vetches, the clovers, rye, buckwheat, spurry, fodder corn, stock beets, cow peas, etc. A succession of crops should be grown, the earliest in most sections being crimson clover, sown the previous summer, and followed by red clover, corn, etc., and ending with cow peas and the vetches. The silo is used to store green food for the winter months, fodder corn being most commonly used in the silo.

A rank growth of forage is required, and the maturity of the crop is not a consideration. The soil should be made very fertile and fertilizers used with a free hand. Farmers can easily test the value of heavy fertilizer applications in soiling, by comparing different parts of the same field, differently fertilized. Apply per acre, just before, or even with the seed, from 400 to 800 pounds of phosphate, and as soon as the plants are well up, top-dress with Nitrate of Soda, using 300 pounds per acre. Top-dress in quite the same manner for second crops. It is a quick, rank growth of green substance that is wanted, and for this purpose no other form of Nitrogen is as quick-acting as Nitrate of Soda.

How Money Crops Feed.

What the Food is.

The substance of plants is largely water and variations of woody fiber, yet these comprise no part of what is commonly understood as plant food. More or less by accident was discovered the value of farm yard manures and general farm refuse and roughage as a means of increasing the growth of plants. In the course of time, the supply of these manures failed to equal the need, and it became necessary to search for other means of feeding plants. The steps in the search were many, covering years of careful investigation, and it is needless to go into a lengthy description here; but, as a result, we have the established fact that the so-called food of plants consists of three different substances, Nitrogen, Potash, and Phosphates.

Its Principal Elements, Nitrate, Phosphoric Acid, Potash.

These words are popular names, and are used for the convenience of the general public. Nitrate of Soda contains an amount equivalent to about 15 per cent. of Nitrogen, 300 pounds to the ton, and cotton-seed meal, for example, about six per cent. More than three pounds of cotton-seed meal are necessary to furnish as much available Nitrogen as one pound of Nitrate of Soda. We value the plant food on the amount of Nitrate Nitrogen it contains, and on this account Nitrate has become a standard name for this element of plant food. In like manner, phosphoric acid and potash are standards, hence the importance of farmers and planters familiarizing themselves with these expressions. We always should think of fertilizers and manures as just so much nitrate, phosphoric acid and potash, as we can then at once compare the usefulness of all fertilizer materials. No doubt other substances are necessary for the proper development of crops, but soils so generally supply these in ample quantities that they may safely be neglected in a consideration of soil needs and plant foods. The food of plants may therefore be understood to mean simply *Nitrate, Phosphoric Acid and Potash.*

Why Farmyard Manure and Other Products are Valuable.

Farmyard manure acts in promoting plant growth almost wholly because it contains these three substances; green manuring is valuable for the same reason and largely for that only. Various refuse substances, such as bone, wood ashes, etc., contain one or more of these plant food elements, and are valuable to the farmer and planter on that account.

The Quality of Manures and Fertilizers.

Nitrate Pre-digested Nitrogen.

While plant food is always plant food, like all other things it possesses the limitation of quality. Quality in plant food means the readiness with which plants can make use of it. In a large sense, this is dependent upon the solubility of the material containing the plant food—not merely solubility in water, but solubility in soil waters as well. Fertilizer substances freely soluble in water are generally of the highest quality, yet there are differences even in this. For example, Nitrate of Soda is freely soluble in soil liquids and water, and is the highest grade of plant food Nitrogen; sulphate of ammonia is also soluble in water, but of distinctly lower quality because plants always use Nitrogen in the Nitrate form, and the Nitrogen in sulphate of ammonia must be Nitrated before plants can make use of it. This is done in the soil by the action of certain organisms, under favorable conditions. The weather must be suitable, the soil in a certain condition; and besides, there are considerable losses of valuable substance in the natural soil process of Nitrating such Nitrogen. By unfavorable weather conditions, or very wet or acid soils, Nitration may be prevented until the season is too far advanced, hence there may be loss of time, crop and money. The quality of nitrogens, such as cotton-seed meal, dried fish, dried blood, and tankage, is limited by conditions similar to those which limit sulphate of ammonia. With these substances, the loss of Nitrogen in its natural air and soil conversion into Nitrate is very great. Perfectly authentic experiments, and made under official supervision, have shown that 100 pounds of nitrogen in these organic forms have only from one-half to three-fourths the manurial value of 100 pounds of Nitrate of Soda.

Defects and Losses in the Use of Ordinary Nitrogens.

Intrinsic Values of all Nitrogens Based on Nitrate as the Standard.

Special Functions of Plant Food.

Unusual Functions of Nitrate.

As stated before, plants must have all three of the plant food elements—Nitrate, Phosphates and Potash—but notwithstanding this imperative need, each of the three elements has its special use. There are many cases in which considerations of the special functions of plant food elements become important.

For example, a soil may be rich in organic ammonia from vegetable matter turned under as green manure, and through a late wet spring fail to supply the available Nitrate in time to get the crop well started before the hot, dry, summer season sets in. In this case the use of Nitrate of Soda alone will force growth to the extent of fully establishing the crop against heat and moderate drouth. This method of manuring is simply Top-Dressing, familiar to us all.

Special Influence of Nitrate on Edible Value of Plant.

Nitrate as plant food seems to influence more especially the development of stems, leaves, and roots, which are the framework of the plant, while the formation of fruit buds is held in reserve. This action is, of course, a necessary preliminary to the maturity of the plant, and the broader the framework, the greater the yield at maturity. The color of the foliage is deepened, indicating health and activity in the forces at work on the structure of the plant. Nitrates also show markedly in the economic value of the crop; the more freely Nitrates are given to plants the greater the relative proportion in the composition of the plant itself, and the most valuable part of all vegetable substances, for food purposes, is that produced by Nitrate of Soda. Nitrate is seldom used in sufficient quantities in the manufacture of "complete fertilizers." Hence the general dissatisfaction with their use.

Potash as plant food seems to influence more particularly the development of the woody parts of stems and the pulp of fruits. The flavor and color of fruits is also credited to potash. In fact, this element of plant food seems to supplement the action of Nitrate by filling out the framework established by the latter.

Phosphoric Acid as a plant food seems to influence more particularly the maturity of plants and the production of seed or grain. Its special use in practical agriculture is to help hasten the maturity of crops likely to be caught by an early fall, and to supplement green manuring where grain is to be grown. It is frequently used in unnecessary excess in "complete" fertilizers.

The natural plant food of the soil comes from many sources, but chiefly from decaying vegetable matter and the weathering of the mineral matter of the soil. Both

Sources of Natural Plant Food.

these processes supply Potash and Phosphoric Acid, but only the former supplies Nitrate. Whether the soil has been fertilized or not, there are certain signs which indicate the need of plant food more or less early in the growth of the crop. If a crop appears to make a slow growth, or seems sickly in color, it does not greatly matter whether the soil is deficient in Nitrate or simply that the Nitrogen present has not been Nitrated and so is not available; the remedy lies in top-dressings of the immediately available form of Nitrate of Soda.

FERTILIZERS EMPLOYED AS A SOURCE OF NITROGEN.

Nitrate of Soda. This is probably the best known and most popular source of nitrogen amongst farmers.

Its origin is the extensive deposits of crude Nitrate of Soda discovered in the rainless districts on the west coast of South America.

Since all nitrogenous compounds must first be converted into nitrates before being assimilated by plants, Nitrate of Soda contains its nitrogen in an easily assimilable form, and is, therefore, quick in action.

Owing to this fact, it almost invariably gives best results when applied in two or more applications, the first being given at the commencement of growth, and the succeeding ones at intervals of from two to three weeks.

Sulphate of Ammonia. The origin or source of this material is coal, which contains 1½ to 2 per cent. of nitrogen. It is chiefly a by-product of gas works. It is slower in its action than Nitrate of Soda, since, in order to render the ammonia available to plants, it must first be converted into a nitrate, which process is performed by certain soil bacteria.

Lime Nitrogen (Kalkstickstoff). A new nitrogenous fertilizer is produced by combining the free nitrogen of the atmosphere with lime and carbon.

1. Kalkstickstoff is an exceedingly fine black powder, which character renders it difficult of application.

2. If mixed with other fertilizers, such as acid phosphate, the mixture rapidly generates a great heat and gases are given off, some nitrogen being lost as ammonia and oxides of nitrogen.

3. In storing, it must be very carefully protected from moisture for the above reason.

4. Being at first rather poisonous to plants, Kalkstickstoff is totally unsuited for application to a growing crop, and should always be applied to the land at least two weeks before seeding.

If these precautions are observed, Kalkstickstoff may give results equal to Nitrate of Soda and sulphate of ammonia on most crops and soils.

Some of the slower acting sources of nitrogen are:

Red Dried Blood, containing 13 to 14 per cent. nitrogen.

Black Dried Blood, containing 6 to 12 per cent. nitrogen.

Hoof Meal, containing 12 per cent. nitrogen.

Tankage, containing 4 to 9 per cent. nitrogen.

Concentrated Tankage, containing 10 to 12 per cent. nitrogen.

The above are all produced from slaughter-house refuse. As will be seen, the lower grades of these substances, viz., Black Dried Blood and Tankage (ordinary) are very variable in composition.

There are numerous other sources of nitrogen, such as the various fish manures, some of which are valuable, if they do not contain too much oil, which is detrimental to the soil, as it hinders decomposition.

Then there are others, such as leather meal, wool and hair waste, and horn meal. The nitrogen in these is, however, so slowly available that their value as fertilizers is small.

It is none the less necessary, however, that the farmer should know of these sources of nitrogen, as they are largely used in fertilizer mixtures, for, as already mentioned, nitrogen is the most expensive ingredient in a fertilizer, and it is a great temptation to the less scrupulous fertilizer manufacturer to get his nitrogen from the cheapest source, and in a mixture it is difficult for a farmer to detect the various substances of which that mixture is composed.

In Nitrate of Soda, Sulphate of Ammonia and Dried Blood, we have three nitrogenous fertilizers, placed in the order of the availability of their nitrogen. Dried Blood is the slowest acting form. . . . Nitrate of Soda is exceedingly quick acting, and, therefore, ought not to be applied long before the crop is ready to assimilate its nitrogen. In its rate of action, Sulphate of Ammonia is intermediate between the two. . . . The special virtue of Nitrate of Soda is due to the fact that it provides a readily available supply of nitrogen to the young plant at a time when nitrification in the soil is only commencing.

Top-Dressings.

Early Growth of Plants.

Top-Dressing, as commonly understood, means simply the application of plant food after seeding, and after the crop has made some growth. It has various objects, but chief among them is the fact that fall sown crops should make an early start in the spring in order to establish an extensive root system (foraging both for food and water), and to protect the soil by shading before the hot, dry days come. The earlier growth of crops is largely a matter of Nitrate plant food, but in the spring the soil is usually wet and cold, both conditions unfavorable for the action of organisms which convert the stored plant food into Nitrates.

How Nitrate Saves Time, Money, and the Crop.

A very late spring may prevent the natural and usual Nitration of this kind of plant food though large quantities may have been applied in the form of organic ammoniates and other crude manures, so that the warm weather finds the crop very backward and a full crop cannot be made. An application of Nitrate of Soda, the most quickly available form of plant food in commercial use as a fertilizer, soon after the crop shows the fresh green color of new growth in the spring, prevents this loss of time and establishes the crop so as to resist drouth and reach and make use of the plant food necessary for the maturity of its stalk and the ripening of its seed.

Nitrate on Fruits.

Top-Dressings are also made to advantage on fruits and vegetables from which the proportion of valuable produce to stalk or vine is so great. With these crops there must be no check in the regular growth of the plants, and Nitrate of Soda alone insures this. With other forms of Nitrogen plant food, rains or cool weather interfere with the regular supply of Nitrate, by checking the action of the organisms which cause the Nitration of crude substances.

How all Nitrogen is, of Necessity, Nitrated, and Slowness of the Process.

Top-dressings are also used on very rolling lands, for the hill tops show lighter-colored foliage in prolonged periods of dry weather, then light applications of Nitrate of Soda are found to be profitable.

On heavy clay soils, spring working is impracticable, as it results in puddling the top soil. In this case fertilizers cannot be worked into the soil even for spring planting, and Nitrate of Soda is used in the form of a top-dressing spread broadcast.

How to Top-Dress.

In top-dressing soils, it is very important to secure an even application over the whole area. As the ordinary application per acre is about 100 pounds, it is difficult to get an even distribution unless the bulk of the material is increased. The best method of doing this is to crush the Nitrate of Soda thoroughly and mix carefully with about its own weight of fine dry loam. This mixture should only be made immediately before using, though the Nitrate may be crushed at any time if mixed at once with an equal bulk of fine, clean sand. Where top-dressings are made with a machine, it is necessary that the mixture be dry.

Top-Dressing Experiments.

Results of Nitrate on Money Crops.

The official Agricultural Experiment Stations have made many experiments to determine the value of top-dressings of Nitrate of Soda, particularly the New Jersey Station. The work of this Station demonstrated the value of Nitrate top-dressing on various fruits and vegetables. The Rhode Island Experiment Station (see Bulletin 71) made a top-dressing test on grass land and the results also indicated a profitable use of this chemical fertilizer.

The experiment was made on three plots, all of which were treated with ample quantities of Phosphoric Acid and Potash. One plot received no Nitrate, one plot a top-dressing of 150 pounds per acre, and the remaining plot a top-dressing of 450 pounds of Nitrate per acre. The seed used was one-quarter red clover, one-quarter redtop, and one-half timothy. The yield in barn-cured hay was as follows:

No Nitrate	1.60 tons.
150 lbs. Nitrate	2.24 tons.
450 lbs. Nitrate	3.28 tons.

The season was not good hay weather on account of an early and severe drouth, yet the top-dressing of 150 pounds of Nitrate of Soda per acre increased the crop of hay 40 per cent., and the top-dressing of 450 pounds gave an increase of 105 per cent. In summarizing the results the Station reports that in spite of weather so unfavorable that there was practically no second crop, a top-dressing of 150 pounds of Nitrate of Soda per acre increased the crop in value $6.94, at a cost for Nitrate of $3.30; a top-dressing of 450 pounds per acre increased the value of the crop $16.98 at a cost of $9.90.

Plant Food Need of Crops.

What Crops Take out of Soils.

The chemical analysis of plants shows the actual amounts of Nitrogen, Potash and Phosphoric Acid they contain, and is a fairly good guide for the omposition of fertilizers. In an examination of the fertilizer requirements of plants by studying their analysis, we must keep in mind the fact that the whole plant must be considered—not only the grain, straw, etc., but also the stubble and roots.

The Storrs Experiment Station of Connecticut reported on an experiment with timothy hay, with results as follows:

	Yield per acre.	Nitrogen.	Potash.	Phos. Acid.
Hay.............	3,980 lbs.	39.0 lbs.	51.5 lbs.	13.9 lbs.
Stubble and roots.	8,223 "	90.1 "	55.8 "	25.2 "
Total.......	12,203 lbs.	129.1 lbs.	107.3 lbs.	39.1 lbs.

Equivalent Quantity of Nitrate Food.

The quantities of plant food actually contained in the crop, computed on the best known fertilizer materials, are represented by 807 pounds of Nitrate of Soda, 215 pounds of muriate of potash, and 280 pounds of acid phosphate. This illustration is interesting as showing the really heavy consumption of plant food by ordinary farm crops. While the yield in this case is a large one, it is precisely such yields all farmers are striving for. It is probably true that an acre application of 800 pounds of Nitrate of Soda would not give profitable returns with this crop; but such crops actually make use of soil Nitrogen and the roughage of the farm, and to do this most effectively top-dressings of Nitrate are advised to "start the crop off" in the spring.

In actual farming operations, the greater part of the timothy crop will be returned to the soil in the form of farmyard manure, much of which will be applied in the fall. A considerable portion of the Nitrogen contained in this manure will be converted into Nitrate during the fall and winter, but there is always a great lack of Nitrate in the early spring, when the plants most need it, and this shortage continues until the soil warms and becomes less charged with water, when the organisms of the soil are enabled to convert the vegetable substance containing Nitrogen into the form suitable for the uses of the plants. Until this action, the plants really starve for Nitrate; a situation instantly relieved by top-dressings of Nitrate of Soda.

Suggestions for Top-Dressing Crops.

It must be understood that fertilizers do not take the place of tillage. However thoroughly a crop may be fertilized, without proper preparation of the soil the result must be more or less a failure. In top-dressing it is very important that the Nitrate of Soda be thoroughly ground, so an even distribution can be made; the fertilizer must go to the plant, not the plant to the fertilizer.

From New Jersey Agricultural Experiment Station.

Abstract of Bulletin 172.

The Cost of Active (Available) Nitrogen.

By Edward B. Voorhees and William S. Myers.

The annual consumption of fertilizers is, as near as can be estimated, 7,000,000 tons, which at an average cost of $25 per ton, makes a total expenditure of $175,000,000.

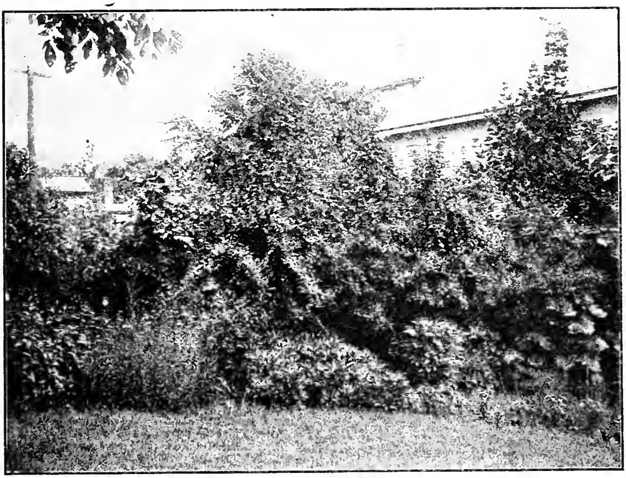
This great quantity of fertilizer is being used for increasing the crops of grain, hay, potatoes, fruits, market garden and staple crops. The money is expended for Nitrogen, phosphoric acid and potash, and notwithstanding the claims made for superior brands and special formulas, the returns have been alone due to the actual amounts of Nitrogen, phosphoric acid and potash that these crops have been able to obtain from the total in the fertilizers used, and there is no mystery of mixing about it.

Of the sum annually paid for the three constituents, Nitrogen, phosphoric acid and potash, if on the basis of an average of:

Ammonia	2%
Available phosphoric acid	8%
Potash	4%

over one-half is paid for Nitrogen, which is the only one of the three essential elements that is likely to suffer any considerable loss. Thus a little less than half of the total expenditure is made for these two elements—phosphoric acid and potash. The remainder is paid for a constituent which in organic form is likely not to be available.

Experiments in Germany, England and the United States, conducted along this line for years, show that,



Quick and Luxuriant Growth of Shrubbery, Produced in Two Seasons by the Use of Nitrate. New Jersey.

on the average, not more than 70 per cent. of the quantities of Nitrogen applied, even in the best forms, is recovered in the crops.

From the standpoint of crop, it is evident that the utilization of Nitrogen is a much more important matter than the use of either phosphoric acid or potash. Although the further fact that a pound of any kind of Nitrogen, capable of being used in a commercial fertilizer, costs from four to five times as much as a pound of "available" phosphoric acid or of potash, is an added reason for greater care in its purchase and use.

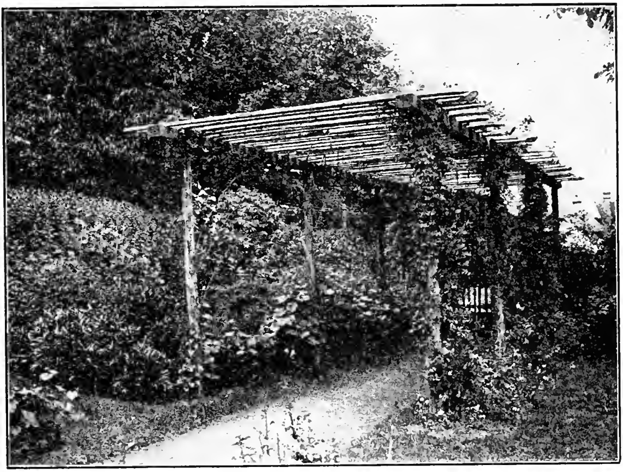
Nitrogen as Nitrate of Soda is the only commercial form of active Nitrogen available for immediate use by most plants; Nitrogen, as ammonia, is less active and less available than the Nitrate.

Organic forms of Nitrogen have to decay first, changing to ammonia and then to Nitrate, and are therefore less active and less quickly available; besides, they vary in their rate of availability according to the source of supply and their character. Materials which are likely to decay quickly, as dried blood, dried meat, dried fish and cottonseed meal, show a fair rate of availability, while forms like ground leather and ground peat show a very low rate of availability. A pound of organic Nitrogen varies much in availability, therefore, according to its source, whether derived from dried blood or peat, or from intermediate products, and if much free sulphuric acid is present, its availability is retarded.

Since Nitrogenous materials are variable in their rate of availability—that is, the rate at which the Nitrogen in them may be absorbed by the plant—the farmer should know the degree of dependence that can be placed on the different materials—he wants his Nitrogen active and available. Hence, the chemical and physical characteristics of the various forms of Nitrogen have been made the subject of very considerable study and investigation, in order that approximate values in respect to availability may be assigned to each form. Sufficient work has been done thus far to establish a trustworthy relationship between the Nitrate, ammonia and organic Nitrogen, in the form of dried blood.

The very extensive investigations conducted at Darmstadt, Germany, show that for the crops tested —namely, barley, oats, rye, wheat, mangels, sugar-beets and potatoes—there was returned in the harvest 62 parts of Nitrate Nitrogen for every hundred parts applied; 44 parts of ammonia Nitrogen for every hundred parts applied, and 40 parts of organic Nitrogen for every hundred parts applied as dried blood. In no case is the recovery equal to two-thirds of the Nitrogen applied; besides, there are wide variations in the amount recovered in the different forms.

In 1898, plant nutrition experiments were begun at the New Jersey Station, one object of which was to study the "relative availability" of these three forms of Nitrogen, using a rotation of corn, oats, wheat and timothy,—crops which, because of their long periods



Privet Hedge at Left and Vines Showing Result of One Year's Use of Nitrate. New Jersey.

of growth would be likely to absorb relatively large proportions of organic Nitrogen. The results of these experiments for two rotations (10 years) show that the recovery for Nitrogen as Nitrate was 62.09 parts per hundred; for the Nitrogen as ammonia 43.26 parts per hundred, and for organic (dried blood Nitrogen), 40 parts per hundred. These results agree almost exactly with those obtained at Darmstadt. Figuring the above-mentioned returns from Nitrate of Soda, since it shows the highest recovery as 100, the relative availability of the Nitrogen as ammonia would be 69.7 and of Nitrogen as dried blood 64.4.

These figures possess a very great practical significance, as they have a direct bearing upon the profitable or unprofitable purchase and use of the Nitrogen contained in the fertilizers now offered in our market.

Commercial conditions fix the price of the various Nitrogenous materials. There is no strict relationship as yet between commercial and agricultural values.

Garbage-tankage, tanned leather scraps and feathers are used in large quantities in some of the large fertilizer factories. The Nitrogen in these products is admittedly much less available than is that in dried blood, and its cost to the manufacturers is small. For garbage-tankage, leather scraps, feathers, wool waste and peat, prices are merely nominal. The cost of handling and reducing these products to forms capable of being used in mixtures, of course, naturally adds to the cost. These materials should be regarded in the same light as the insoluble phosphates and potash compounds—amendments rather than sources of direct supplies of available plant-food—and be paid for accordingly.

Since their establishment, the Experiment Stations have consistently urged the farmers to be guided in their purchase of fertilizers, not only by the quantities of the constituents present in the mixtures offered, but also by the kind that is used in them, pointing out the importance of selecting brands which contain high percentages of available plant-food, more especially of Nitrogen, because of its relatively greater importance and its higher cost. The results obtained in the investigations referred to emphasize very strongly the wisdom of such advice in reference to the most valuable element—Nitrogen.

A concrete example will make clearer the commercial phases of the question. The analysis of the various brands sold in the State of New Jersey in a recent year, shows an average of 2.5 per cent. of total Nitrogen, divided as follows:

Nitrate	.48%	or 19% of the total
Ammonia	.77%	or 30% of the total
Organic	1.32%	or 51% of the total

Assuming that the forms of organic Nitrogen used in these brands were as good as in dried blood, it would require 1.55 pounds of the organic Nitrogen to furnish as much "available" Nitrogen as is contained in 1 pound of Nitrate of Soda Nitrogen and 1.43 pounds of the ammonia Nitrogen to furnish as much "available" Nitrogen as is contained in one pound of the Nitrate of Soda Nitrogen. Yet, merely because of commercial conditions, the farmer paid a higher price per pound for his organic Nitrogen than he paid for his Nitrate and his ammonia Nitrogen. Using the same relations that exist in the commercial cost of Nitrogen, the actual prices paid were for organic Nitrogen 26.52 cents per pound, ammonia Nitrogen 23.73 cents and Nitrate Nitrogen 23 cents. At these prices, the Nitrogen purchased in New Jersey last year cost the farmers about $1,157,400 and in the entire country nearly sixty times as much.

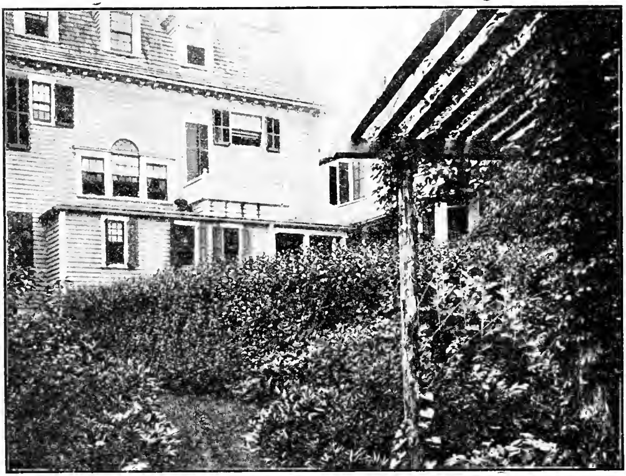
If, however, the returns from the different forms of Nitrogen were in the same proportion, as indicated in the experiments, which must be admitted to be relatively correct for Nitrate and ammonia, and, assuming that the organic was as good as that in dried blood, the cost of the "available" Nitrogen in the three forms actually was:

Per lb.		Per lb.
For organic..41 cts.	While the farmer	For organic...14.8%
For ammonia.34 cts.	should have paid, on	For ammonia.16.1%
For Nitrate..23 cts.	the basis of availability	For Nitrate...23.0%

and a saving to the farmers of the State of $383,940 would have been effected. If, therefore, instead of buying organic and ammonia Nitrogen, Nitrate of Soda only had been purchased, the same gain in crop from the use of the Nitrogen could have been purchased for $733,460 instead of $1,157,500.

Assuming that practically the same relations in forms of Nitrogen existed for all the fertilizers made and sold in the whole country this year, the actual cost of the Nitrogen was, in round numbers, $60,000,000, while, on the basis of efficient availability, it should have cost but $43,000,000.

The point of importance, therefore, is the price that is paid for the organic forms of Nitrogen. In the above discussion, it has been assumed that the organic Nitrogen contained in the fertilizers has been derived from dried blood, or from similar materials. As a matter of fact, however, dried blood does not constitute even a large proportion of the organic Nitrogenous materials used—the bulk of the Nitrogen being derived from products of a lower grade. Various kinds of



Hedge of California Privet Three Years Old, Fertilized for Three Years by Nitrate. New Jersey.

meat and bone, tankage, dried fish, fish scrap, cottonseed meal, garbage-tankage, leather meal and even peat, being used to supplant products of the higher grade. These Nitrogen-carriers, have been shown to have a wide range in availability, the leather and peat rating in availability as low as 4 in comparison with Nitrate at 100 and barnyard manure as low as 3.

It may be urged, first, that these products possess some value as sources of Nitrogen and, second, they have physical uses as an absorbent and in improving the condition of mixtures containing Nitrates, acid phosphate and potash salts, and, that proper conservation of natural resources demands that waste Nitrogenous materials should be utilized. The points are *conceded*, but let no farmer pay a high Nitrogen price for a mere absorbent filler or a conditioner. The Experiment Stations do not discourage, but strongly encourage, the utilization of waste products containing Nitrogen. They would be false to their duty to the farmers, however, if they did not clearly point out to them what is known of the real agricultural value of such products. It is not merely a question of use—it is a question of cost.

It is not economy to save refuse Nitrogenous materials, if the cost of the Nitrogen to the farmer is greater and his returns less than may be obtained by the use of Nitrogen from materials of known value. Farmers have been and are now spending thousands of dollars for Nitrogen for which they do not receive even a proportionate return.

To the farmer, it should be purely a business proposition. He buys Nitrogen, in order that he may get a return in his crop. If in one case 100 pounds of Nitrogen contributes 60 pounds to the crops upon which it is applied, and in another 100 pounds contributes but 40 pounds to the crops, the purchaser should not pay the same for the second as for the first, for if he did so he would pay 50 per cent. more per pound for his "available" Nitrogen. That is, if the cost of one hundred pounds of Nitrate Nitrogen was $14, the cost of the dried blood, one hundred pounds of Nitrogen should be but $10, for the basis of value is the amount available in each case.

How Nitrate of Soda Helps Crops.

The highest agricultural authorities have established by careful experimentation that 100 pounds per acre of Nitrate of Soda applied to crops has produced the INCREASED yields tabulated as follows:

Barley	400	lbs. of grain.	
Oats	400	" "	
Rye	300	" "	
Wheat	300	" "	
Potatoes	3,600	"	Tubers.
Hay, upwards of	1,000	"	Barn cured.
Cotton	500	"	Seed cotton.
Sugar Beets	4,000	"	Tubers.
Beets	4,900	"	"
Sweet Potatoes	3,900	"	"
Cabbages	6,100	Pounds.	
Carrots	7,800	Pounds.	
Turnips	37	per cent.	
Strawberries	200	quarts.	
Onions	1,800	Pounds.	
Asparagus	100	bunches.	
Tomatoes	100	baskets.	
Celery	30	per cent.	
Hops	100	pounds.	

Nitrate of Soda is a plant tonic, and an energizer; is it NOT a stimulant in any sense of the word.

It may be used alone, without other fertilizers, as a Top-dressing, at the rate of not more than 100 pounds to the acre.

Profits from the Use of Fertilizers.

The aim usually in the use of artificial fertilizers is to so supplement soil supplies of plant-food as to obtain a profit, and, as already intimated, the profits for the different crops will, to some extent, be in proportion to their economical use of the constituents applied. Still, one should not be deterred from the use of fertilizing materials, even if the conditions should render the application apparently wasteful, or a small recovery of the constituents applied, provided the increase in yield will more than pay the cost of the application. The farmer should calculate what increase in crop it is necessary for him to obtain in order to make the use of fertilizers profitable, and if only this is obtained he should not condemn their use. Many persons seem to have gotten the impression that there is some mystery connected with fertilizers, and that their use is a gamble at best, and are not satisfied unless the returns from the investment in them are disproportionately large. We very often hear the statement that, by the use of certain fertilizers, the crop is doubled or tripled, as if this were a remarkable occurrence and partook of the nature of a mystery. Such results are not mysterious—they can be explained; they are in accordance with the principles involved.

In an experiment on celery it was shown that the weight of celery from an application of 400 pounds per acre of Nitrate of Soda was two and one-half times greater than that obtained on the land upon which no Nitrate was used, and that very great profit followed its use. This result, while remarkable in a way, was not mysterious; if all the Nitrogen applied had been used by the crop, there would have been a still greater increase. It simply showed that where no extra Nitrogen had been applied the plant was not able to obtain enough to make the crop what the conditions of the season and soil, in other respects, permitted. *In other words, that the soil did not contain a complete food; the Nitrogen was necessary to supply the deficiency.* Favorable conditions are, however, not uniform, and variations in return from definite applications must be expected.

It is quite possible to have a return of $50 per acre from the use of $5 worth of Nitrate of Soda on crops of high value, as, for example, early tomatoes, beets, cabbage, etc. This is an extraordinary return for the money invested and labor involved; still, if the value of the increased crop from its use was but $10, or even $8, it should be regarded as a profitable investment, since no more land and but little more capital was required in order to obtain the extra $5 or $3 per acre. It is the accumulation of these little extras that oftentimes change an unprofitable into a profitable practice.

PRACTICAL SUGGESTIONS AS A RESULT OF EXPERIMENTS.

I. For Crops of High Commercial Value.

Market Garden Crops.

It is well understood by all market gardeners that, in their business, liberal manuring must be practised, and that the manures used must contain an abundance of Nitrogen, that may be quickly used by the plant, if rapidity of growth and early maturity are to be attained. The experiments with Nitrate of Soda were, therefore, planned to show in which directions the benefits from its use were observed—whether, for example, in the larger yield of a crop of the same general character; or whether, together with the larger yield, there was an earlier maturity of those crops in which early maturity is an important factor; or whether the marketable quality was improved, thus returning a larger profit for the same yield; or whether all of these factors were involved; and the results showed that, as a whole, benefits were obtained in all these directions. The more important crops of this class were included in these experiments.

Early Table Beets.

In the growing of this crop, whose value may range from $300 to $600 per acre, the amount of plant-food annually applied is usually far in excess of that removed in the crops of any year, in order to guarantee against any shortage of food should unfavorable weather conditions intervene; the crop must be kept growing at all hazards. In good practice an application of from fifteen to twenty tons of manure and about one ton of a high-grade commercial fertilizer are used per acre. The plants are usually grown under glass, and transplanted as soon as the land is fit to work. Hence the questions asked by the experimenter were, first, whether an additional application of Nitrogen in the form of a Nitrate would be a profitable practice in connection with this heavy application of all of the plant-food constituents, and second, how much should be used. The applications, therefore, ranged from 400 to

700 pounds per acre. The results from the experiments of two years were emphatic in showing an increase in yield and a considerable profit each year, and though the profits were not in proportion to the amount of

Ash.

Without Dressing. With 300 lbs. Nitrate of Soda to the Acre.

Nitrogen applied, the largest net returns were obtained from the heaviest applications; the average net return per acre from 400 pounds was $24.40, and from 700 pounds, $47.55. The influence of the Nitrate was noticeable mainly upon the earliness of crop. In the first experiment the yield of the first picking was 63 per cent. greater from the Nitrated plots than from the one upon which no additional Nitrate had been used. The extra early yield, for which the highest prices were obtained, was increased from 8.3 per cent. on the plot on which 400 pounds were used to 12.8 per cent. on the plot which received 700 pounds per acre, an increased yield at a less cost per unit of harvesting—points of great importance.

Method of Using the Nitrate.

The amounts used may range from 400 to 800 pounds per acre, depending upon the conditions, always remembering that the richer the soil and the better its condition the larger will be the amount of Nitrate that can be used to advantage. The beets are usually transplanted, and one-half of the amount of Nitrate of Soda used may be applied either before transplanting or immediately after, and in about three weeks the balance may be applied. In applying Nitrate after the plants have made considerable growth of top, care should be taken to distribute it as near as possible between the rows, or, if broad-casted, only when the leaves are perfectly dry, so that all of the salt may reach the soil, and thus not be liable to injure the plants. Where it does not seem practicable to make the application of Nitrate of Soda separately, then the Nitrate, in the quantity desired, may be mixed with the commercial fertilizer and all applied at the same time. This practice saves labor and danger of injuring the foliage, though it may result in a slight loss of the Nitrate, as it should be applied long enough before the plants are set to permit of its thorough distribution in the soil. Still, the danger of loss is not great, unless the season is so extremely wet as to prevent cultivation.

Asparagus.

In the case of asparagus, which is a perennial, the final results of the experiments have not yet been secured, though the experience of practical growers is unanimous in favor of its use. This crop, as is the case with early beets, requires heavy manuring or fertilizing, or both, for the highest profit. The advantage of the extra dressings of Nitrate of Soda over other forms of Nitrogen lies chiefly in the fact that it may be appropriated immediately, either for supplying the needs early in the season or to stimulate the

Norway Maple.

With Manure Alone. With Manure and 300 lbs. Nitrate of Soda to the Acre.

growth of tops after cutting has ceased and the crowns are exhausted. Where manure is used alone in liberal amounts, the top-dressing with Nitrate would not be likely to be so useful an adjunct as where commercial fertilizers, containing high percentages of minerals, have been used, as it must be remembered here, as always, that Nitrogen is not a complete food, but an element of food, and cannot exert its full effect except in the presence of the necessary supply of the mineral elements.

Methods of Using Nitrate.

In the early spring, as soon as the land is fit to cultivate, the beds are ploughed or cultivated, throwing the earth away from the crowns, and commercial fertilizers, rich in Nitrogen—5 to 6 per cent.—are applied, over the row, at the rate of 800 to 1,000 pounds per acre. As asparagus is a perennial, and the growth in the spring depends largely upon the food stored up in the roots in the fall, the effect of the spring application is not so noticeable in the early cuttings, but materially benefits the later cutting. Commercial beds are usually cut for about two and one-half months, and this long period of continuous removal of shoots reduces the vitality of the crowns, and because the vigor of growth and size of the tops measures, to a marked degree, the size of the next crop, as soon as cutting is finished from 250 to 400 pounds per acre of Nitrate of Soda should be applied. The roots immediately absorb this available form of Nitrogen, which stimulates and strengthens the plant, and enables it to appropriate the excess of minerals which have been applied, and, as a consequence, a large, vigorous and healthy growth of top is made, which not only results in storing the food in the roots for use the next season, but it enables the plant to resist the ravages of the rust. There is no other form of Nitrogen that can be used or other means by which this object can be so readily accomplished as by a liberal supply of Nitrate of Soda, and the result is, not only a larger yield, but a greater proportion of large shoots, which increases the market value of the crop; the growers who practice this system have no difficulty in contracting their entire crop from year to year at very remunerative prices.

Early Tomatoes.

A careful study of the special needs of plants shows that there is no other one crop that responds more favorably to the use of immediately available Nitrogen than early tomatoes. The influence of the use of Nitrate is not only shown in the increase in the yield—in some cases practically doubling it—but in the improved quality of crop, and because of the larger crop an increased maturity is virtually secured. These are all points of extreme practical importance. The results of all the experiments conducted in different parts of the country and in different seasons show an average gain in yield of about 50 per cent., with an average increased value of crop of about $100 per acre.

Methods of Practice.

In the growth of this crop two methods are used, depending largely upon the character of the soil and its previous treatment in reference to commercial fertilizers or manures. In the first, where the farmyard manure and commercial fertilizers, rich in minerals, have been used on previous crops, then Nitrogen in the form of Nitrate only is used, and the application ranges from 150 to 250 pounds per acre. By this method the yields are not so large, but the crop is usually earlier, and the net profit is quite as great as if larger applications of manure or fertilizer were made at the time of setting the plants. The object is early tomatoes, and, under average conditions of season and markets, any application of fertilizer or any practice which would tend to encourage a later growth or longer season would reduce proportionately the net profits.

In the other method, farmyard manures are usually spread upon the soil in the fall or winter, thoroughly worked into the soil in the spring. A fertilizer containing chiefly phosphoric acid and potash is applied broadcast previous to setting the plants. and at the time of setting an application of 100 to 150 pounds per acre of Nitrate of Soda is applied around the hill or over the row. After two or three weeks, depending upon the season and the relative growth of the plants, another application of Nitrate of Soda at the same rate is made. This, because it minimizes the interruption in the feeding of the plant by furnishing immediately available Nitrogen, causes not only an increase in the yield and marketable quality of the entire crop, but it materially increases the quantity of early fruit. The results of four years' experiments show that, by this method, the value of the increased yield of what may be regarded as extra early fruit averaged about $45 per acre.

How to Apply Nitrate.

As in other cases, care should be used in the application of Nitrate; it should not come in too close contact with the plants, and, if broadcasted after the plants are set, it should be done when they are dry, so that all of the Nitrate may reach the soil. Where a larger quantity is used, as, for example, 300 pounds or more, it is very desirable that fractional dressings should be made, though care should be used not to make the second application too late, as it encourages a later growth of plants and retards maturity.

Early Cabbage.

Cabbage is a gross feeder, and the crop can utilize large quantities of plant-food to good advantage. The experiments with this crop show that even where the land has been fertilized with what would be regarded as reasonable amounts of fertilizers adapted for the purpose, extra dressings of Nitrate have given very profitable returns. The yield has been increased from 40 to 80 per cent. and the net value of crop from $53 to $80 per acre. The experiments also show that what may be regarded as a large quantity of Nitrate, namely, 400 pounds per acre, is superior to any smaller quantity, and further, that this had better be applied in two rather than in a greater number of fractional dressings, as the later applications have a tendency to disproportionately increase leaf growth and retard heading. The most remarkable effect of the Nitrate is shown in the influence it exerts upon the marketable quality of the crop. In the experiments conducted the addition of Nitrate resulted in more than doubling the value of those heads which were marketable—that is, where no Nitrate was applied, $1 per hundred was received, and where 400 pounds of Nitrate were used the price was $2.50 per hundred. These results suggest a reason for the lack of success of many growers, who depend solely upon applications of mixed fertilizers.

Methods of Application.

On soils well adapted for the crop — medium sandy loams — the land should be plowed early and well cultivated. If manures are readily attainable, a dressing of ten tons per acre may be applied and well worked into the soil; previous to setting the plants a fertilizer rich in Nitrogen, one containing 6 to 7 ammonia, 6 to 8 phosphoric acid, and 6 to 8 potash, should be applied, preferably broadcast, at the rate of 800 to 1,000 pounds per acre. At the time of setting, or very shortly after, Nitrate of Soda, at the rate of 200 pounds per acre, should be applied, preferably along the row, and cultivated in; this followed two or three weeks later with a second dressing of 200 pounds. The effect of these applications—that is, the presence of an abundance of available Nitrogen—will be to stimulate and strengthen the plant, so that it will make use of all of the other food in the soil, and be able to overcome, in a great degree, any unfavorable conditions that may prevail later in the season. The natural tendency of the plant to absorb food is gratified, and a maximum crop is the result.

Early Table Turnips.

This is a crop of very considerable importance in market garden districts, and in certain sections is very profitable. The profit, other things being equal, is measured by the earliness with which the crop may be gotten into the market. The gains obtained in the experiments from the use of Nitrate have ranged from 30 to over 100 per cent., according to the amount applied and method of application. The increased value of crop, due to the Nitrate, averaged about $30 per acre—a very handsome return from the use of the extra fertilizer.

Methods of Application.

Where soils have been previously liberally fertilized, particularly with the mineral elements, the recommendations for fertilizers, which have in practice proved very satisfactory, are as follows: Prepare the soil early and apply a light dressing of manure, either previous to plowing or after plowing, and harrow in well, and apply a commercial fertilizer rich in minerals, say, with a composition of 2 per cent. Nitrogen, 8 per cent. phosphoric acid and 5 per cent. potash, at the rate of 1,000 pounds per acre. After the plants have germinated and are well started, apply, broadcast, 150 pounds per acre of Nitrate of Soda, following this in two or three weeks with a second application of 150 pounds. The first dressing will serve to stimulate leaf growth and a deep penetration of root, and the second dressing will encourage a rapid growth of the turnip, so necessary if high quality is to be obtained. Applications made later than one month after the seeding usually encourage too large a leaf growth, thus reducing the yield of early crop. In the experiments three equal dressings of 133 pounds each reduced the yield by over 3,000 pounds per acre below that which was obtained in two equal dressings of the same amount as suggested herewith. The effect of the third dressing seemed to be to induce growth of top rather than root. The increase in the maturity—that is, the quantity of early crop—will be directly increased, in so far as the Nitrate induces a larger crop, which is one of the first results of its application.

Sweet Corn. Very great progress has been made in the growth of sweet corn for the early market, due both to the development of harder varieties and to greater care in the selection and use of fertilizing materials. These hardy varieties of sweet corn are now frequently planted as early as March as far north as New Jersey, and, when planted so early, the soil supplies of Nitrogen are yet unfavorable for the change of organic or other forms of Nitrogen into the Nitrate form. Hence, Nitrate should constitute a large part of the nitrogenous food of the plant if early maturity is to be accomplished. Practice has shown that, by small fractional dressings of Nitrate early, maximum results may be obtained. In the preparation of the soil for the growth of this crop, therefore, considerable organic nitrogenous material may be used to advantage.

A good practice is to manure the soil, either during

Methods of Practice.

the fall or winter, with from ten to twelve tons per acre, and apply previous to planting or setting the plants (in many cases the plants are started in the plant-house), a fertilizer rich in phosphoric acid and potash, also containing organic forms of Nitrogen. At time of planting use a compost in the hill, and use the Nitrate as a side dressing after the corn is well rooted. The advantage of the compost and organic forms of Nitrogen is that they supply the soil with an abundance of readily fermentable material, which, to some extent, warms the soil, besides containing substances useful in later stages of growth. Nitrate may be applied in three dressings, at the rate of 100 pounds per acre in each dressing, and the dressings should be so distributed as to cover the season of growth—that is, as soon as plants begin to form ears the last application of Nitrogen may be made, which encourages a quick growth of the ears and also makes them much larger. The increased gains per acre when the Nitrate has been used in this way have ranged from $18 to $40—a very profitable use of Nitrogen, as the gain is really in excess of that which would be obtained by average methods of manuring.

Muskmelons.

Soils suitable for the growth of muskmelons are preferably light, sandy loams, not naturally well supplied with any of the constituents of plant growth. The crop does not require large quantities of plant-food, but must have the needed amount in available form early in the season. Experiments that have been conducted through several seasons show that the best form of Nitrogen for this crop is the Nitrate, and that preferably two applications should be made. The increase in yield from the addition of Nitrate of Soda has averaged, practically, 100 per cent., with an average increased value of crop of $100 per acre. The increased value is obtained because of a large crop of finer quality, as a very marked influence of the added nitrogenous substance is noticed in marketable quality of the total crop, reducing very materially the percentage of culls. The experiments showed that, while the percentage of culls, where no

Nitrogen was applied, averaged 40 per cent., the average per cent. of culls on the fertilized area was but 25 per cent., indicating that the normal development of fruit requires a sufficient amount of available Nitrogen.

Methods of Practice.

On light soils, apply broadcast during fall or winter, 8 to 10 tons of manure, which should be plowed in early in spring. After the land is prepared, a high-grade fertilizer should be applied broadcast, at the rate of 600 to 800 pounds per acre, and harrowed in previous to planting. After the plants are well started, apply 100 pounds per acre of Nitrate of Soda; before the vines begin to run, make an additional application of 100 pounds per acre. Care should be taken in the application of the Nitrate, as suggested in the case of the other crops, not to allow the salt to come in contact with the foliage of the plants.

Cucumbers.

In the case of cucumbers, heavier soils may be used, and larger quantities of fertilizers applied. In our experiments, the application of Nitrate in addition to regular methods of fertilization resulted in a very large increase in crop—over 100 per cent.—and an increase in net value of over $60 per acre. The amounts of Nitrate applied may range from 250 to 300 pounds per acre, and it should preferably be distributed more evenly throughout the season than in the case of the melons; 300 pounds per acre, in three applications, gave the best results. The effect of the Nitrate here, as in the case of melons, was particularly noticeable in maintaining a rapid and continuous growth of vine and fruit, thus materially reducing the proportion of culls. For growing this crop to best advantage, the soil should either be well manured or a commercial fertilizer, rich in all of the constituents, should be applied at the rate of 400 to 600 pounds per acre, previous to planting; and after the plants have well started, 100 pounds per acre of Nitrate of Soda should be applied; this to be followed with two further dressings of the same amount. The time between the dressings may range from two to three weeks, according to season.

Celery.

Celery is a crop that responds most profitably to an application of an abundance of available Nitrogen. This fertilizer not only increases the yield, but very materially improves the quality of the crop. Where the soil is naturally rich, or where what may be regarded as good methods of practice, in reference to fertilizers, are followed, extra applications of Nitrate result in very largely increased yields and proportionate improvement in quality. In the experiments that were conducted, it was shown that where ordinary treatment was given, and a small and unprofitable crop was obtained, the addition of a few dollars' worth of Nitrate changed the crop into a very profitable one; and in the case of a soil that was regarded as good enough to produce a fair crop, the addition caused a large increase in total crop, and a very marked improvement in the quality. The selling price of roots grown with Nitrate was 150 per cent. greater than where none was applied, and 100 per cent. greater than where an insufficient amount was used. The increased value per acre of the crop from the best use of the Nitrate was over $250.

Methods of Application.

The celery crop is expensive, both in plants and in labor, and since the cost of these items is the same whether the crop is large or small, intensive systems of feeding the crop usually give excellent returns. The crop is also very much improved in quality if the conditions are made favorable for continuous and rapid growth, hence an abundance of moisture and of immediately available food are prime essentials. The former can be controlled to a large extent by good methods of culture, but the best culture of the best soils is not capable of providing the necessary food, and, of the essential elements of food, Nitrogen seems to be the one that contributes especially to rapidity of growth and to the formation of stalk which possesses that peculiar crispness which in so marked a degree measures marketable quality. Soils that are deep, moist and rich in organic matter are best suited for the crop; these should be heavily manured, say, at the rate of ten to fifteen tons per acre, and should also receive liberal amounts of high-grade commercial fertilizer, at the rate of 600 to 800 pounds per acre, all applied broadcast previous to setting the plants. After the plants are well started, apply 200 pounds per acre of Nitrate of Soda along the row, and, if the weather is dry, cultivate it in, though, ordinarily, the moisture in the soil is sufficient to cause an immediate distribution of the salt; and in three to four weeks make a second application of Nitrate of the same amount and in the same manner. The two applications of Nitrate, of 200 pounds each, will, it is believed, give, on the average, better returns than smaller amounts or a greater number of applications, though the conditions of season may warrant such changes from this method as the judgment of the grower may dictate.

Peppers.

The growing of peppers has become a considerable industry in market garden districts in recent years. Studies of the special needs of the crop show that, on good soils, well adapted for the plant, additional dressings of Nitrate are necessary for best results—the gain in yield averaging 35 per cent., and the increased value of crop due to the added Nitrates averaging $30 per acre. A large quantity—300 pounds per acre—seems to be much superior to any less amount, and, owing to the fact that peppers continue to form during the entire period of growth, the distribution of the Nitrate throughout the season is desirable where large quantities are applied. Where more convenient the first application of Nitrate may be applied at time of setting the plants, in order to prevent any delay in growth after setting. The later fractional applications are distributed throughout the season, two or three weeks apart.

Early Potatoes.

In the growing of early potatoes it is essential that an abundant supply of Nitrogen be at the disposal of the plant. The experience of growers has clearly demonstrated this fact, and, until commercial fertilizers came into general use, most growers used large quantities of yard manure, in order that the plant should suffer no lack of this element. With the introduction of commercial fertilizers, the question of greatest importance has been the source of Nitrogen best suited to meet the demands of the special early growth. The experiments which have been conducted with a view to answering this question have shown clearly that while Nitrate is most useful, a combination of the Nitrate with the quickly available organic forms, as dried blood, or with both organic and ammonia forms, is preferable to the use of any single form.

Methods of Practice.

On good potato soils, therefore, a good fertilization should consist of from 800 to 1,000 pounds of a fertilizer containing Nitrogen, 4 per cent.; available phosphoric acid, 8 per cent., and potash, 10 per cent.; one-third of the Nitrogen at least to be derived from Nitrate of Soda and the remainder from quickly available organic forms. On soils in good condition the fertilizer may be applied in the row at the time of planting, though many prefer to apply one-half of the desired amount broadcast previously and the remainder in the row with the seed. Where there appears to be a deficiency of Nitrogen, the application of 100 pounds of Nitrate per acre at the time of blossoming will encourage the rapid growth of tubers, though retarding, to some extent, the time of ripening.

Sweet Potatoes.

The sweet potato finds its most congenial home in a light, sandy soil, the physical character of the soil measuring, to a large extent, the quality of the crop, though the method of fertilization will also influence this to a certain extent. This plant seems to have the power of acquiring from the soil Nitrogen that is inaccessible to other plants, and thus, where large applications of this element are made, a tendency to undue growth seems to be encouraged, and also to change the marketable quality of the tubers, causing a long, rooty growth, rather than a compact, nodular form. The use of a small amount of Nitrogen is, however, desirable, an increase of from 50 to 70 bushels per acre being secured from such use. Hence, soils rich in Nitrogen, or those upon which Nitrogen has been previously applied in considerable quantities, do not produce tubers of the character demanded by our northern markets—a small, round tuber, which cooks dry and has a nutty flavor. These characteristics of quality cannot be secured in crops grown on heavy soils, nor on sandy soils too liberally supplied with Nitrogen.

Methods of Practice. The fertilizer may be applied at the time of making up the rows, in order that it may be evenly distributed before the slips are planted. This will encourage immediate growth of plant, and the small quantity of Nitrate which is applied early in the season will not militate against the proper development of the tuber, as an absence of Nitrogen in the soil after the Nitrate has been taken up will discourage the formation of the rooty form of tuber, which is marketable at a lower price.

Experiments have also demonstrated the necessity in the soils of an abundance of minerals, and a fertilizer containing 2.5 per cent. Nitrogen, 7 per cent. available phosphoric acid and 10 per cent. potash, one-half the Nitrogen to be drawn from Nitrate, seems to meet the requirements better than one containing a larger amount of Nitrogen.

II. For Crops of Low Commercial Value.

Hay and Grain. The growth of hay and the cereals, wheat and rye, forms a very important part of the farming interests of the Eastern, Middle and Southern Coast States. The areas of these crops in eighteen States, including Tennessee and Kentucky, are, in round numbers, as follows:

Hay	15,000,000	acres.
Wheat	8,000,000	"
Rye	772,000	"

In most of these States large quantities of commercial fertilizers are used, either because the soils are naturally poor or because they have been depleted of their original constituents by continuous cropping, and, even with added fertilizers, the yields are not large enough to make the crops in themselves highly profitable. In many States the yield in particular districts is large, but the average yield of hay is but 1.25 tons per acre, of wheat, but 13 bushels per acre, and but 15 bushels of rye. The aggregate production of these crops is, however, very large, and, because of the conditions which prevail, it is likely that their growth will continue for some time to come, though it is eminently desirable that the average yield should be increased.

One of the chief reasons for the low average yield is that the farming is on the "extensive" rather than on the "intensive" plan. The relatively large areas used are not well prepared for the seed, and the fertilizers applied do not fully supplement soil supplies of plant-food. These conditions, too, are not liable to change at once, because the farmers are not yet prepared to adopt the more rational intensive system; the adjustment to new conditions requires time. The suggestions here given as to the use of top-dressings of nitrogenous substances are therefore of primary importance, because, if followed, they will enable the farmer to obtain more profitable crops, and will encourage the gradual adoption of better systems of practice.

The farmers have, however, reached the point where they are asking the general question: "How shall I profitably increase the yields of these crops?" They are not satisfied with present conditions, nor with the general advice to supply the crops with additional plant-food. The advice is not definite enough, and they are not sure that the cost of expensive plant-food will be returned in the immediate crop, and they cannot afford to wait for future crops to return an interest on the invested capital. As soon as it is made clear that a profitable increase in crop from the use of fertilizers is a reasonable thing to expect, then the questions are—*first*, "What shall I use?" *second*, "How much shall I use per acre?" and *third*, "When and how shall it be applied?" Experiments that have been conducted with the use of Nitrate of Soda answer all of these questions in a definite and specific way.

Hay.

In the case of hay, from timothy and other grasses, the experiments that have been conducted answer the first question—"What shall I use?"—as follows: Use Nitrate of Soda, because it is a food element that is especially needed; it is soluble in water and can be immediately taken up by the plants and supplies them with that which they need at the time they need it—it can be used by them early in the spring before other forms of applied Nitrogen are usable and before other soil supplies are available. The results of experiments conducted through a period of nine years, and in different sections of the State, show that upon soils which will produce crops ranging from one to three tons per acre, a gain in yield of from 9 to 54 per cent., or an average increase of 32.7 per cent., may be expected from the use of from 100 to 150 pounds per acre, which would show an average gain in yield of 654 pounds per acre; based on the average yield of this section of the country of 1.25 tons per acre, the gain would be 820 pounds. This increase at an average price of $12 per ton would mean about $5 per acre, or $2 more than the cost of the material. A very satisfactory profit, when it is remembered that it is obtained at the same cost of labor and of capital invested in land.

How Much Shall be Applied.

The second question, as to how much shall be applied:—experience teaches that on good soils, in a good state of cultivation, 150 pounds per acre would be regarded as the most useful amount, though on poor soils, 100 pounds would be better, and on richer soils, as high as 200 or 250 pounds per acre may be used with advantage. The reason why a smaller amount is recommended on poor soils is because on such soils there is liable to be a deficiency of the mineral elements, and inasmuch as the Nitrate is not a food complete in itself, but an element of food, the plant would be unable to utilize it to the best advantage in the absence of the necessary minerals. Where the soils are good or under the intensive plan, larger amounts may be used, as under this system all the constituents are supplied in reasonable excess, besides, every precaution is taken to have the physical condition of the soil so perfect as to provide for the easy distribution and absorption of the food applied. In experiments conducted in Rhode Island the largest profit was obtained from the application of 450 pounds per acre, together with the necessary minerals. This method of practice is one which should be the ultimate aim, and can be accomplished by gradually increasing the amounts as the profits from the crops grown from the application of smaller amounts warrant.

Methods of Application.

The experiments, the results of which are confirmed by experience, also answer the third question, as to when it shall be applied. Apply as a top-dressing in spring, after the grass has well started, when the foliage is dry, and preferably just before or just after a rain. If applied when vegetative functions are active, it is immediately absorbed, and not only strengthens the plant but causes it to throw its roots deeply into the soil and to absorb more readily the mineral food, and thus utilize to a fuller degree the amount of Nitrate applied. Frequently, however, not only is the yield increased, but the quality of the hay is improved—that is, there is proportionately more nitrogenous substance in the hay than in that obtained where no Nitrogen has been used, so that unless the Nitrate has been absorbed uniformly we cannot expect the yield that may be calculated from the amount of Nitrogen applied. These experiments suggest, further, that, owing to the difficulty of evenly distributing a small amount of Nitrate of Soda, and owing, also, to the fact that, on soils that have been seeded with grass, there is frequently a deficiency of mineral elements, a mixture may preferably be used which is rich in Nitrate, usually one-half, the balance consisting of acid phosphate, ground bone and muriate of potash. The soluble minerals are readily carried to the roots of the plants, but the ground bone feeds the surface roots, and the Nitrate is absorbed quite as readily as if not used with any other material. This method is to be recommended whenever the land is in good condition, and it is desired to keep up the content of the mineral constituents in the soil, as well as to avoid any danger of overfeeding with Nitrogen, which would have a tendency, particularly in the warmer climates, of causing a softer growth and formation of mildew. This is liable to occur where the Nitrogen is in excess and the ration is not well balanced.

Wheat.

The answer to the questions as applied to wheat are, in essence, the same, though modified in particular points, owing to the fact that the wheat is grown for grain, rather than for weight of total produce, as in the case of hay, and also because wheat, being seeded in the fall, has not so large a root system as grass, and therefore greater care should be used in the application of the material. Nitrate of Soda is, however, the substance that is likely to give the most satisfactory results as a top-dressing, because, as already pointed out, it is soluble, and can thus reach every point of the soil without the necessity of cultivation and it is immediately available, and thus supplies food at once or at the time most needed, energizing the plants weakened by the winter and strengthening those already vigorous and enabling them to secure a larger proportion of the mineral elements. The time of application should be early in the spring, or after growth has started.

Gains from the Use of Nitrate of Soda.

The results of experiments conducted to answer this question show a gain in both grain and straw from the top-dressing of Nitrate of Soda. The yields per acre, without the top-dressing, ranged from eleven to twenty-seven bushels of grain per acre and from 1,500 to 1,800 pounds of straw, thus showing a wide variation in the character of the soils used and in seasons, making the average of the results generally applicable.

The gain in yield of grain ranged from 25.9 to 100 per cent., while that of straw ranged from 54 to 100 per cent., or an average of 60.8 per cent. increase in the case of the grain, and 83.8 per cent. increase in the case of the straw. The value of these increased yields, at average prices, shows a large profit in all cases. Applying this to the average yield per acre of wheat and straw, namely, thirteen bushels of wheat and 1,600 pounds of straw for the Eastern and Southern States included in our discussion, we find a gain of 7.9 bushels of wheat and 1,340 pounds of straw, and a valuation of seventy-five cents per bushel for wheat and $6 per ton for straw, which prices probably represent the average, though not as high as are now prevailing, the total value of the increase is $9.95, or a net gain of $6.20 per acre, using the price of $50 per ton for Nitrate of Soda. The profit here indicated is a good one and should make wheat raising more encouraging, besides stimulating the farmer to better practice in other directions. The calculated yields from the use of Nitrate are not unreasonable to expect, since on good wheat soils and with fairly good management, without the additional Nitrate, the average yield is over twenty bushels per acre.

The Amount to Apply.

In reference to the second question, as to how much Nitrate shall be applied, the experiments show that on soils in a good state of cultivation, those that will produce about fifteen bushels per acre without top-dressing, 150 pounds per acre, the average amount used in the experiments, would be the most useful; though, on poorer soils, which would average ten to twelve bushels per acre, 100 pounds would be better, for the reasons already discussed in the case of hay.

On better soils, where quantities larger than 150 pounds per acre seem desirable, it is strongly recommended that two applications of equal weight be made; the first, when the plants have well started, and the second, when the crop is coming into head. Very often the season is such as to encourage a rapid change of the insoluble Nitrogen in the soil, in which case too large an application in the spring would tend toward an undue development of leaf and the ripening would be impaired, hence the advantage of dividing the amount is apparent, as, if the season is good and the growth normal, the second application may be dispensed with. Where the soil is liable to be deficient in minerals, and this is often the case, the Nitrate may be mixed with other materials, as recommended for hay, the excess of minerals not used for the wheat providing for the following crop.

Rye.

The three experiments with rye in 1894 confirm the conclusions reached in both the experiment on hay and on wheat, that Nitrate of Soda as a top-dressing proves desirable in effectually increasing the yield of both grain and straw, and which is accomplished at a profit. The average yield of crops without top-dressing ranged from 9.3 to 15.4 bushels of grain, and the increase from the application of 100 pounds of Nitrate of Soda ranged from 21 to 37 per cent. for grain, and from 33.5 to 37 for straw, or an average increase of 28.5 per cent. for grain and 35.7 for straw. The yield obtained without top-dressing is not so large as in the case of the wheat, nor is the increase proportionately as large, due undoubtedly to the fact that the rye is usually grown on poorer land than wheat, and that only 100 pounds are used, though this small amount is recommended because of the relatively lower price of grain. Applying this percentage increase, however, to the average yields, as shown by the States mentioned, namely, fifteen bushels of rye, and 1,800 pounds of straw per acre, we have a gain of 4.28 bushels of grain and 603 pounds of straw. At sixty cents per bushel for the grain, and $12 per ton for the straw, the gain is $6.18, or a net profit from the use of Nitrate of Soda of $3.93 per acre, a very handsome return for the investment. The suggestions as to the amount and time to apply are practically the same as for the wheat and hay, though, owing to the fact that the straw is relatively more valuable than the grain, larger applications may be made for rye than for wheat, as an abnormal increase in the proportion of straw would not result in lowering the total value of the crop.

Experiments with Forage Crops.

At this Station during the years 1899 to 1902 seven experiments were conducted with Nitrate as a top-dressing on forage crops, the Nitrate being used in addition to the manures and fertilizers generally used, and the following tabulations show the yield and gain per acre obtained. It will be observed that in all cases a very marked increase, due to the application of Nitrate, occurred on all crops except the barley, which, owing to unfavorable weather conditions, did not make a large yield. Applying this percentage increase to what has been shown to be average yields of these crops without Nitrate, we have the following table, which shows the gain per acre and the value of the increase on all crops at an assumed value of $3 per ton:

Yield of Forage Crops Per Acre.

	Number of Experiments.	Fertilizer.		Increased Yield.	Percentage, Gain.	Average Yield.	Increased Yield.	Value of Increased Yield at $3 per Ton.
		Nothing.	Nitrate of Soda.					
		lbs.	lbs.	lbs.		lbs.	lbs.	
Rye..........	1	9,520	13,100	3,580	37.6	10,000	3,760	$5.64
Wheat........	1	9,280	15,000	5,720	61.6	10,000	6,160	9.24
Barnyard Millet........	2	14,355	21,540	7,185	50.0	14,000	7,000	10.50
Corn..........	1	20,400	26,800	6,400	31.4	20,000	6,280	9.42
Oats and Peas.	1	6,250	9,530	3,280	52.5	10,000	5,250	7.88
Barley........	1	2,400	4,720	2,320	96.6	8,000	7,728	11.59

It will be observed that the value of the increased crop ranges from $5.64 to $11.59 per acre—a profitable increase in every case, as the average cost of the Nitrate did not exceed $3.60. This profit does not take into consideration the fact that the average increase for all the crops was over 50 per cent., thus reducing, in this proportion, the area required for the production of a definite amount of food—a point of vital importance in the matter of growing forage for soiling purposes. In other words, it is shown that, not only is there a profitable gain, but that with these crops the application of Nitrate of Soda made it possible to double the number of cattle or the number of cows that could be kept on a definite area.

In the case of the wheat and rye the application was made when the plants were well started in the spring. In the case of the spring or summer-seeded crops the applications were made after the plants were well started and root systems well established and ready for the rapid absorption of food. In raising forage crops the best results, in fact, satisfactory results, can only be

Methods of Application.

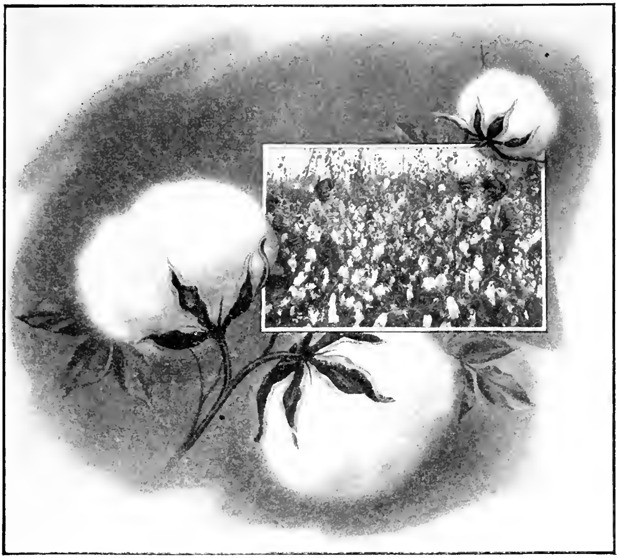
obtained when grown under the intensive system. The soil must be well prepared and an abundance of all the elements of plant-food supplied. Hence, the application of Nitrate may be greater than is usually recommended for grain crops under the extensive system.

Although there are many valuable suggestions offered by the experiments, at least two are of fundamental importance, and cannot be too strongly urged upon the attention of farmers:

1. That the constituents Nitrogen, phosphoric acid and potash, as found in commercial supplies furnishing these elements, do serve as plant-food, nourishing the plant in the same manner as those in home manures, and should, therefore, be liberally used, in order to guarantee maximum crops.

2. Of these constituent elements Nitrogen is of especial importance, because it is the one element which, in its natural state, must be changed in form before it can be used by the plants. Hence, its application in an immediately-available form is especially advantageous for quick-growing vegetable crops, whose marketable quality is measured by rapid and continuous growth, and for those field crops which make their greatest development in spring, before the conditions are favorable for the change of the Nitrogen in the soil into forms usable by plants.

Staple Crops.



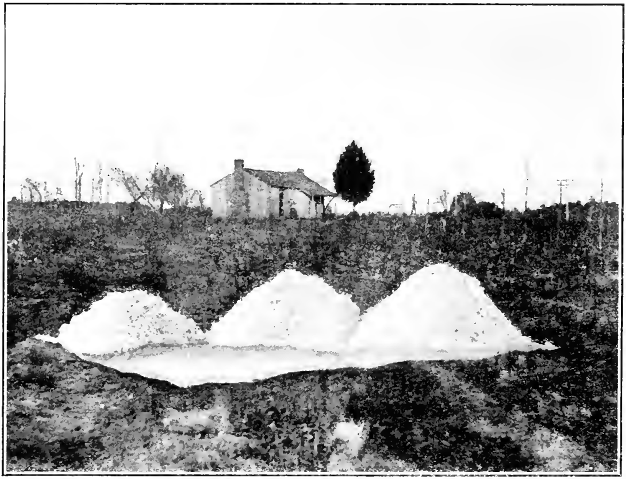
Cotton and Fiber Plants.

Cotton is profitably grown on nearly all kinds of soil, but does best perhaps on a strong, sandy loam. On light uplands the yield is light, but with a fair proportion of lint; on heavy bottom lands the growth may be heavy, but the proportion of lint to the whole plant very much reduced.

The preparation of the soil must be even and thorough; light soils should be plowed to a depth of six inches, heavy soils about eight inches. The rows should be four feet apart; on very rich soils the hills may be made twelve inches apart, but, on the light soils common to cotton sections, twenty-four inches is a better space between plants. About one bushel of seed per acre is the usual allowance.

Many fertilizer formulas have been recommended, and by all kinds of authority, and green manuring is widely advised as a means of getting a supply of cheap ammonia; but, with this crop especially, cheap ammoniates are very dear. The cotton plant should have stored up all the food it needs by the 1st or 15th

Products of Auburn Cotton Plots, Group 1.



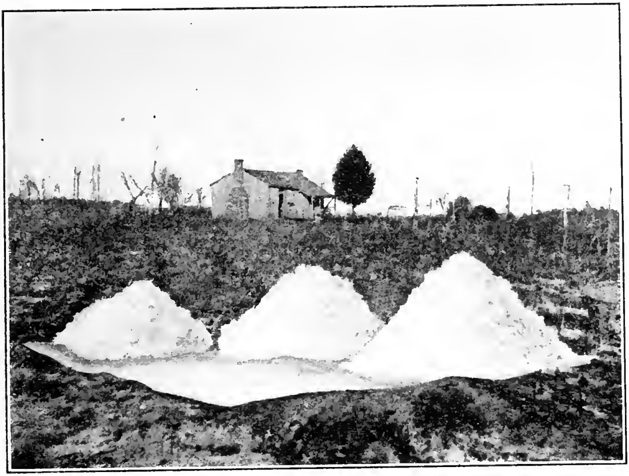
Yields of Seed Cotton.

Plot 1.	Plot 3.	Plot 4.
750 lbs.	1272 lbs.	1440 lbs.

of August; from this time on growth should be checked that the plant may develop the formation of seed and lint. If, on the contrary, plant food is still supplied late in the season, new growth is the result, and in consequence a lessened production of lint and seed. The lower grade ammoniates, such as cotton-seed meal, green manuring, tankage, and dried blood, continue to supply available Nitrogen until checked by cold weather, hence these forms of ammoniates are not desirable for the most economical production of cotton. In order to supply the necessary plant food for the earlier stages of growth, so much of these low grade ammoniates must be used that injury from lack of ripening is almost sure to occur.

The most rational way of fertilizing cotton is to apply the phosphoric acid and potash with the seed,

Products of Auburn Cotton Plots, Group 2.



Yields of Seed Cotton.

Plot 1.	Plot 3.	Plot 4.
930 lbs.	1284 lbs.	1776 lbs.

or just before seeding. As soon as the plants are well above ground, top-dress along the rows with 100 pounds of Nitrate of Soda per acre, and work in well with the cultivator. This furnishes the cotton plant with precisely the Best Form of Nitrogen, Nitrate, for rapid growth, and does not continue to push the plant long after new growth should have ceased.

One hundred pounds of Nitrate of Soda may be used as a top-dressing four weeks after planting.

Successful results have been obtained by using Nitrate alone, either at the time of planting, at the ratio of 100 pounds to the acre, or a spoonful of this salt placed around and near each cotton bush later, mixing it thoroughly with the dry soil. Avoid placing the Nitrate on the plant or in contact with it.

Fertilization and Cultivation of Cotton.

Bulletin of North Carolina Department of Agriculture.

Culture. Cotton is generally grown on ridges. This is necessary on wet soils, but on all fairly well-drained upland and sandy soils we are convinced that level and frequent shallow cultivation, as was indicated for corn, is the best and most economical method to follow in growing cotton. Ridge culture may give better results in very wet years, but taking the seasons as they come the advantage will lie, we think, with flat culture.

On light lands it will be good practice to apply Nitrate as a side-dressing about the middle of June. Good results come from the use of it in this way on heavy types of land. Where land does not produce a good stalk of cotton, and fertilizers are used which contain only a moderate amount of Nitrogen, or ammonia, good results are obtained from a side-dressing of 50 to 100 pounds of Nitrate of Soda per acre. The Nitrate should be distributed along one side of the row, or where there is a ridge in the middle it may be put on this, and when the ridge is thrown out the Nitrate will be thrown on two sides of the row.

Fertilizing Cotton. The Alabama Agricultural Experiment Station at Auburn, Alabama, has made some interesting experiments in fertilizing cotton. Experiments were conducted in many different parts of the State and on various kinds of soil.

It was noticed that in nearly every case 96 pounds of Nitrate of Soda, when used with acid phosphate, gave a better yield than 240 pounds cotton-seed meal when

Experiments with Fertilizers on Cotton.

Locality and Character of Soil.	No Fertilizer.	240 lbs. Acid Phosphate, per Acre.	NITRATE. 96 lbs. Nitrate of Soda, 240 lbs. Acid Phosphate, per Acre.	240 lbs. Cotton S. Meal, 240 lbs. Acid Phosphate, per Acre.	NITRATE. 96 lbs. Nitrate of Soda, 240 lbs. Acid Phosphate, 64 lbs. Muriate Potash, per Acre.
	Yield per Acre. Lbs.	Yield per Acre. Lbs.	Yield per Acre. Lbs.	Yield per Acre. Lbs.	Yield per Acre. Lbs.
Barbour Co., Sandy Loam..	624	672	1216	768	1020
Elmore Co., Gray Sand.....	469	736	1088	960	1088
Elowah Co., Red Loam.....	240	616	1000	720	952
Greene Co., Sandy.........	104	512	960	1056	1256
Clay Co., Soil Red.........	389	480	800	704	848
Calhoun Co., Mulatto Soil..	171	480	640	624	816
Lawrence Co., Clay Loam...	235	600	864	688	904
Cullman Co., Sand and Gravel..................	347	928	1080	1096	1120
Madison Co., Clay Loam...	312	448	800	544	800
Randolph Co., Sandy Loam.	288	384	752	544	544
Butler Co., Light Sand.....	200	640	744	760	800
Marengo Co., Dark Sand...	648	816	936	784	968

used with the same quantity of acid phosphate. The 240 pounds of cotton-seed meal contained more Nitrogen than 96 pounds of Nitrate, and cost more than the Nitrate, yet did not give, as a rule, as good results. As a rule, potash did not pay, except on sandy land. While the "no fertilizer" acre gave only a small yield, the best results were obtained from the combination of Nitrate, phosphate and potash, but where the land was fairly good, the potash did not seem to be necessary.

Cotton-seed meal has been an economical source of Nitrogen, but it tends to make the soil sour, stale and mouldy. Its use should never exclude the use of Nitrate Nitrogen, *i.e.*, Nitrate of Soda, at the rate of 100 pounds to the acre.

Two bales of cotton may be made on the same land with the same labor which now makes one. Nitrate of Soda fed to growing crops at the right time repays its cost many times over.

If there is no Nitrate present, the plant must wait until the Nitrogen in the cotton-seed meal becomes nitrated, which, in cool, damp soil takes a considerable time. Thus the plant, in its most critical stage, is held back and checked in its growth, *from which it never fully recovers.* On the other hand, if a small quantity of Nitrate is used, the plant can take it up at once and get a good strong start by the time the cotton-seed meal is converted into the Nitrate form, the only form that can be used by the plant.

Profitable Use of Nitrate of Soda on Cotton.

In forty tests in 1904 at the South Carolina Experiment Station, where Nitrate of Soda was used at the rate of 200 pounds to the acre, the yield was 1,740 pounds of seed cotton per acre, compared with an average yield of 868 pounds per acre for thirty-four plots on which various fertilizers were used, and an average yield of 425 pounds per acre for six unfertilized plots.

The table on page 77 shows the average yearly yields per acre for the four years during which the experiments were carried on, together with the profits shown by the use of various fertilizers, is condensed from similar tables on pages 21, 22 and 23 of Bulletin 145 of the South Carolina Experiment Station, Clemson College, S. C., and from a report for 1910 from the same station.

Doubling the Cotton Crop a Problem of Sane Fertilizing.

Should the world's cotton spinning demands require the doubling of the American cotton crop within the next five or ten years, along what lines of development in means and methods could it be most economically accomplished?

This is a question which some consider a practical proposition. They look forward to an era, after the

Average Yearly Profits from Use of Fertilizers for the Years 1906, 1907, 1908, 1910.

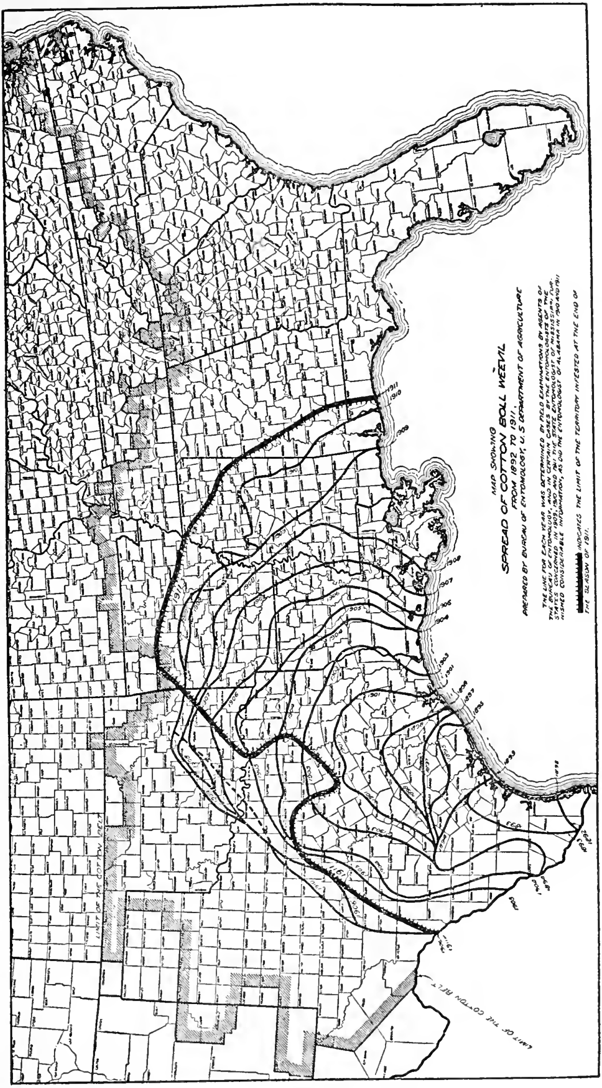
Kind of Fertilizer	Average Yield, per Acre.	Yield Above Unfertilized Plots. (Increase due to fertilizer.)	Value of Increase at 4 cents per Pound.	Average Cost of Fertilizer.	Gain from Use of Fertilizer.
None	481 lbs.	......	......	......	......
Acid Phosphate	690½ "	209½ lbs.	$ 8.38	$ 3.45	$ 4.93
Muriate of Potash	550½ "	69½ "	2.78	1.94	.84
Acid Phosphate, Muriate of Potash	751½ "	270½ "	10.82	5.39	5.43
Acid Phosphate, Muriate of Potash, Cottonseed Meal	865¼ "	384¼ "	15.37	7.17	8.20
Acid Phosphate, Nitrate of Soda	1004¾ "	523¾ "	20.95	9.15	11.80
Acid Phosphate, Muriate of Potash, Nitrate of Soda	1013 "	532 "	21.28	12.04	9.24
Acid Phosphate, Cottonseed Meal, Nitrate of Soda	1060 "	579 "	23.16	11.88	11.28
Acid Phosphate, Muriate of Potash, Cottonseed Meal, Nitrate of Soda	1113¾ "	632¾ "	25.31	13.81	11.50

current depression is passed, of new areas of investment. A new period of railway construction is then expected to break out in Asia, Africa, Latin-American countries and in Australasia. Railway building always brings with it an enormous demand for cotton textiles and many capable judges recognize that neither the present mill capacity nor the available supply of cotton may be adequate for the world's requirements of the chief textile fabric five or ten years hence.

Fertilization is 50 per cent of the producing factors necessary to increase the yield of cotton up to the average Egyptian productiveness. Egypt's cotton average is about 400 pounds to the acre, and in 1912 it was 426 pounds against our own average of about 180. The other elements include seed selection, the application of natural manures, plowing under green manures and thorough tillage and drainage.

But fertilizing depends very largely on the ingredient which is selected to do the fertilizing. Of the three chief fertilizing elements—potash, phosphoric acid and nitrogen—the nitrates are by all means the most important because they supply the energizing element in plant life. The rational use of nitrates, of about 100 pounds an acre, is therefore, the most important fertilizing principle in the increase in the production of cotton, because it is the factor which enables the plant to make the most out of its environment. The great difference between the American fertilizing methods and those of Europe and Egypt is in the proportion of nitrogen used in increasing the size of the crops. The average composition of fertilizers sold in the United States is inferior in this main element of available nitrogen. The cotton belt, which now ranks first in fertilizer consumption, includes in the average composition of fertilizers about eight parts of phosphoric acid, four of potash and two of nitrogen, of which the whole is never available, that is, free to act in its fertilizing function. In Europe and Egypt the composition is eight of phosphoric acid, four of potash and four and one-half of nitrogen, practically all of which is available.

The American farmers' progress, especially in the cotton country, is being hindered by the use of inferior fertilizers. A pure fertilizer law is needed as much as a pure food law. Farmers do not know enough about the availability of the higher grade fertilizer ingredients which are necessary to more intensive cultivation. Germany imports more nitrates than we do, for her territory of about the size of Texas. Last year that country took 700,000 tons, compared with 550,000 tons imported by the United States. Europe ships her



The Spread of the Cotton Boll Weevil from 1892 to 1911.

phosphoric acid here and takes her nitrates from Chile, in which the energizing plant-producing power is nearly all available.

If cotton growing, on the 35,000,000 acres now under that plant, could be brought by rational fertilizing and by ordinary improvements in seed selection and soil treatment to the Egyptian standard of 400 pounds to an acre, the yield of the country could thereby be raised to 28,000,000 bales a year. Rural credit institutions for the supply of necessary capital at low cost and the diversion of immigration into the cotton states, would insure the necessary labor and capital. One thing more—the invention of a successful mechanical cotton picker—and the American cotton crop would be on a fair way to double itself within another decade.

Flax and Hemp.

For Hemp. 100 pounds Nitrate per acre may be applied as a top-dressing at the time of planting.

For Flax. 100 pounds Nitrate per acre may be applied as a top-dressing at the time of planting.

Tobacco.

The value of tobacco depends so much upon its grade, and the grade so much upon the soil and climate, as well as fertilization, that no general rules for tobacco culture can be laid down. Leaving out special ones, such as Perique, the simplest classification of tobacco for the purposes of this book is as follows: *Cigar.*—Tobacco for cigar manufacture, grown chiefly in Connecticut and Wisconsin. *Manufacturing.*—Tobacco manufactured into plug, or the various forms for pipe smoking and cigarettes. All kinds of tobacco have the same general habits of growth, but the two classes mentioned have very different plant food requirements.

Cigar tobaccos generally require a rather light soil; the manufacturing kinds prefer heavy, fertile soils. In either case, the soil must be clean, deeply broken, and thoroughly pulverized. Fall plowing is always practised on heavy lands, or lands new to tobacco culture.

Tobacco may be safely grown on the same land year after year. The plant must be richly fertilized; it has thick, fleshy roots, and comparatively little foraging power—that is, ability to send out roots over an extensive tract of soil in search of plant food.

Fertilizer for tobacco is used in quantities per acre as low as 400 pounds, and as high as 3,000 pounds. It should always be supplemented by a top-dressing of

Tobacco.

No Nitrate. Virginia Experiments. 100 lbs. Nitrate of Soda per acre.

Nitrate of Soda, along the rows of young plants, ranging from 200 to 400 pounds per acre. Manufacturing tobaccos are particularly benefited by the application of Nitrate of Soda. While the production of leaf may be enormously increased by abundant use of this Nitrate, the other plant food elements should also be used to secure a well matured crop. In the case of cigar tobaccos, Nitrate should be used exclusively, as it is difficult to secure a thoroughly matured leaf unless the supply of digestible Nitrogen is more or less under control, a condition not practicable with ordinary fertilizers. Should the crop at any time before mid-August take on a sickly, yellow color, Nitrate of Soda should be broadcasted at once, along the rows, and at the rate of 200 pounds per acre. If this broadcasting can be done just before a rain, the results will appear more promptly.

Tobacco growing is special farming, and should be carefully studied before starting in as a planter. For small plantations, the plants are best bought of a regular seedsman. The cultivation is always clean, and an earth mulch from two to three inches in depth should be maintained—that is, the surface soil to that depth kept thoroughly pulverized.

Tobacco.

At the Kentucky Experiment Station, experiments were made with fertilizers on Burley Tobacco. The land was "deficient in natural drainage," so that the fertilizers could hardly be expected to have their full effect. Yet, as will be seen by the following table, the profits from the use of the fertilizers were enormous:

Experiments on Tobacco at the Kentucky Experiment Station.

Fertilizer per acre.	Yield of tobacco—pounds. Bright.	Red.	Lugs.	Tips.	Trash.	Total.	Value of tobacco per acre.
1. No manure..............		200	360	60	540	1160	$67.20
2. 160 lbs. Nitrate of Soda...	230	450	310	90	530	1610	138.40
3. 160 lbs. sulp. of potash; 160 lbs. Nitrate of Soda.....	190	755	605	120	140	1810	190.45
4. 320 lbs. superphosphate; 160 lbs. sulp. of potash; 160 lbs. Nitrate of Soda	310	810	420	10	360	2000	201.20

The tobacco was assorted by an expert and the prices given as follows: Bright and red, fifteen cents per pound; lugs, six cents per pound; tips, eight cents per pound; trash, two cents per pound.

One hundred and sixty pounds Nitrate of Soda, costing about $3.75, increased the value of the crop $71.20 per acre!

We recommend for tobacco a mixture of 200 pounds Nitrate of Soda, 300 pounds superphosphate, and 200 pounds sulphate of potash per acre. This mixture would cost about $28.00 per ton and would contain over 6 per cent. of Nitrogen. This is nearly twice as much Nitrogen as would be obtained in a "complete fertilizer" or "special tobacco manure," costing $35.00 per ton.

Grass Growing for Profit.

Timothy and related grasses feed heavily on Nitrogen; they are able to transform it completely into wholesome and digestible animal food. When full rations of plant food are present a good crop of grass will remove upwards of the equivalent of the active fertilizer ingredients of 200 pounds of Nitrate of Soda, 200 pounds muriate of potash and 200 pounds of phosphate. These amounts are recommended to be applied per acre as top-dressing for grass lands; and if wood ashes are available 400 pounds per acre will be very beneficial in addition to the above. Grass lands get sour easily, especially when old, and when they do, one ton of lime per acre should be harrowed in before seeding down anew. The seeding must be done before September, and the above-mentioned ration should be used as a top-dressing the following spring, soon after the grass begins to show growth.

If all the conditions are favorable from three to five tons of clean barn-cured hay, free from weeds, may reasonably be expected. When grass crops are heavy and run as high as 4½ tons per acre field-cured, it is safe to allow 20 per cent. shrinkage in weight for seasoning and drying down to a barn-cured basis. Nitrate of Soda, the chief constituent of the prescribed ration, pushes the grass early and enables it to get ahead of all weeds, and the crop then feeds economically and fully on the other manurial constituents

1. Product of one square foot of ground in field yielding over three tons per acre of cured timothy hay fertilized with Nitrate of Soda.

2. Product of one square foot of ground in adjoining field (not fertilized with Nitrate of Soda) yielding one ton per acre of cured hay.

Highland Experimental Farms, New York.

present in the fertilizer mentioned in the formula and present in the soil.

When clean No. 1 hay sells above $16.00 per ton the financial results are very satisfactory. Nitrate can sometimes be used alone for a season or two and at very great profit, but a full grass ration is better in the long run for both the soil and crop. Generally speaking, 100 pounds of Nitrate, if used under proper conditions, will produce an increase of from 1,000 to 1,200 pounds of barn-cured, clean timothy hay, the value of which shall average from $8.00 to $10.00. Compared with the value of the increased hay crop, it pays well to use Nitrate liberally on grass lands.

Making Two Blades of Grass Grow Where One Blade Grew Before.

Grass is a responsive crop and the part played by mineral chemical fertilizers, as proven in Rhode Island, shows the striking effect of Nitrate on yields and feeding quality.

Since all the other fertilizers were alike for the three plots and had been for many years, and since the general character of the soil and the treatments the plots had received were uniform, any differences must be ascribed to the influence of the varying quantities of Nitrate of Soda. These differences, so far as they are shown by the weights of the crops for four years are given in brief below:

Yield of Cured Hay Under Different Rates of Nitrogenous Fertilization.

	Yield of Cured Hay.				
Nitrate of Soda applied.	1899, Lbs.	1900, Lbs.	1901, Lbs.	1902, Lbs.	Average Yields in Tons.
None..............	5,075	4,000	3,290	2,950	1.9
150 lbs. per acre*...	6,300	5,600	5,550	4,850	2.8
450 lbs. per acre*...	6,913	8,200	9,390	8,200	4.1

* Amount slightly reduced in 1901 and 1902.

What the Figures Show.

These figures show a uniform, consistent and marked advantage from the use of Nitrate of Soda; and the effect of its absence is shown by the steady decline of the yields on the *no*-Nitrate plot from year to year. In each year the use of 150 pounds of Nitrate gave increased yields over the plot without Nitrogen, the gain varying from 1,200 to almost 2,300 pounds, an average gain of about seven-eighths of a ton of hay. Three times this amount of Nitrate did not, of course, give three times as much hay, but it so materially increased the yield as to show that it was all used to good advantage except, perhaps, in the second year. This was an exceptionally dry year and but one crop could be cut. The advantage from the Nitrate showed strikingly in the production of a rapid and luxurious early growth while moisture was still available. This supply of readily soluble food comes just when it is most needed, since the natural change of unavailable forms of Nitrogen in the soil to the soluble Nitrates proceeds very slowly during the cool, moist weather of spring. The full ration of Nitrogen, 450 pounds of Nitrate, more than doubled the yield of hay over that produced on the no-Nitrate plot in 1900 and in the next two years it nearly tripled the yield. The average increase over the 150 pound plot was one and three-tenths tons and over the plot without Nitrogen was two and five-eighths tons.

Effect on Quality of Hay.

How Nitrate Improves the Quality of the Hay.

Almost as marked, and certainly more surprising and unexpected, was the effect of the Nitrate upon the quality of the hay produced.

The hay from the plots during the first season was of such diverse character that different ton values had to be placed upon it in estimating the profit from the use of fertilizers. That from the no-Nitrate plot, since it contained so much clover at both cuttings, was considered worth only $9.00 a ton; the first cutting on the small Nitrogen ration was valued

Types of Characteristic Rock Shattering (1).

Types of Characteristic Rock Shattering (2).

Types of Characteristic Rock Shattering (3).

at $12.00 and the second cutting at $10.00; while $16.00 and $12.00 were the values given to the first and second cuttings respectively on the plot receiving the full ration of Nitrate.

But the reduction in the percentage of clover was not the only benefit to the quality of the hay. The Nitrate also decreased the proportion of red top as compared with the finer timothy. This tendency was noticed in the second year, when a count of the stalks on selected equal and typical areas showed 13 per cent. of timothy on the 150 pound plot, and 44 per cent. on the 450 pound plot. In the third year the percentages of timothy were 39 per cent. and 67 per cent., respectively, and in the fourth year the differences were even more marked.

An Alkaline Soil Necessary for Grass.

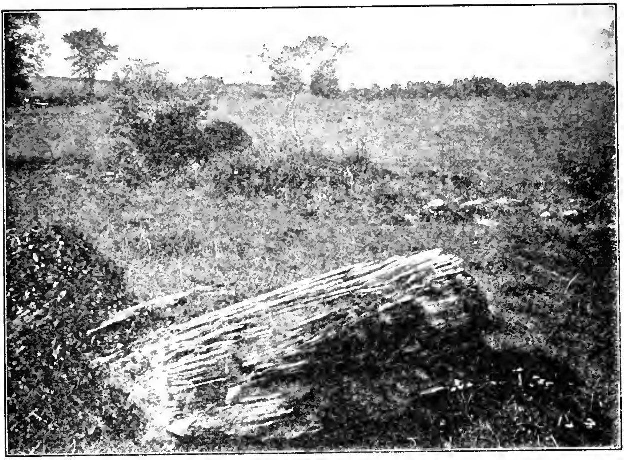
Timothy is a grass which will not tolerate an acid soil, and it is probable that the liming given these plots in 1897 did not make them as "sweet" as would have been best for this crop. Now, when Nitrate of Soda is used by plants, more of the nitric acid is used than of the soda and a certain portion of the latter, which is an alkali, is left to combine with other free acids in the soil. This, like lime, neutralizes the acids and thus "sweetens" the soil for the timothy. Red top, on the contrary, does well on soils which are slightly acid, and so would have the advantage over timothy in a soil not perfectly sweet. With the assistance of the Soda set free from the Nitrate, the timothy was more than able to hold its own and thus to make what the market calls a finer, better hay; and since the market demands timothy and pays for it, the farmer who sells hay is wise if he meets the demand.

How Nitrate Neutralizes Soil Acids and Sweetens the Soil.

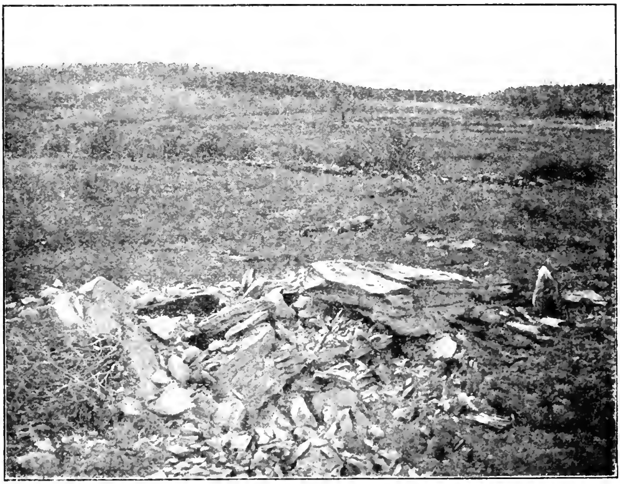
Financial Profit from Use of Nitrate.

How It Pays.

Frequently more plant food is paid for and put on the land than the crop can possibly use, the excess being entirely thrown away, or, at best, saved to benefit some subsequent crop.



Rock before Blasting One Pound of Forty Per Cent. Dynamite.



Same Rock Shattered by the Explosion of Dynamite.

This was far from the case in these trials. Indeed, it was found by analysis of the hay that more potash was removed by the crops of the first two years than had been added in the muriate used, consequently the amount applied upon each plot was increased in 1901 and in 1902. The Nitrogen requirement of the crops was found to be slightly less than was supplied in 450 pounds of Nitrate and the amount was reduced to 400 pounds in 1901, and changed to 415 pounds in 1902. The Nitrate on the second plot was also reduced in proportion. The phosphoric acid, however, was probably in considerable excess, since liming sets free phosphoric acid already in the soil and so lessens the apparent financial profit; but not to an excessive degree.

Excess of Value of Hay Over Cost of Fertilizers.

Nitrate of Soda applied.	1899.	1900.	1901.	1902.	Average
None...............	$ 6.09	$13.42	$12.13	$ 7.44	$ 9.77
150 lbs.*...........	14.34	20.37	23.97	16.52	18.80
450 lbs.*...........	19.62	30.40	40.70	32.74	30.86

* Slightly reduced in 1901 and 1902.

Practical Conclusions.

From these striking results it must be evident that grass land as well as tilled fields is greatly benefited by Nitrate, and that it would be to the advantage of most farmers to improve the fertility of their soils by growing good crops of grass, aided thereto by liberal fertilizing.

Top-Dressing Grass Lands.

The application should be in the form of a top-dressing, applied very early in the spring in order that the first growth may find readily available material for its support and be carried through the season with no check from partial starvation.

On land which shows any tendency to sour, a ton to the acre of slaked lime should be used every five or six years. This makes the land sweet and promotes the growth of grass plants of the best kinds.

Lime should be sown upon the plowed land and harrowed into the soil. Top-dressing with lime after seeding will not answer, and. in the case of very acid soils, the omission of lime at the proper time will necessitate re-seeding to secure a good stand of grass.

Economical and Profitable Practice.

All the elements of fertility are essential so that ordinarily complete fertilizers may be used, Nitrate being used as a top dresser, though on some soils rich in phosphoric acid or potash, one or both of these ingredients may be used in small quantity. This is particularly true of phosphates after lime has been applied to the soil, since lime aids to set the phosphoric acid free from its natural insoluble combinations.

Grass seems to demand less phosphoric acid than was applied in the test; but it responds with increasing profit to applications of Nitrate of Soda up to 250 pounds to the acre when ample supplies of potash and phosphates are present.

No stable manure has been used upon the field under experiment for over twenty years.

The Bulletins of the Rhode Island Agricultural Experiment Station, or Farmers' Bulletin No. 77, published by the United States Department of Agriculture, tells how and when to use lime. Details of excellent grass experiments, to be found in recent Bulletins issued by the Rhode Island Agricultural Experiment Station, Kingston, Rhode Island, tell about Nitrate of Soda.

Nitrate of Soda as Used in Clark's Grass Cultivation.

It may not be out of place here to mention the fact that Mr. Clark's success in obtaining remarkably large yields of hay for a number of years, an average of 9 tons of cured hay per acre for 11 years in succession, has been heralded throughout the United States. He attributes his success largely to the liberal dressings of Nitrate of Soda which he invariably applies to his fields early in the spring, and which start the grass off with such a vigorous growth as to shade and crowd out all noxious weeds before they get fairly started and which result in a large crop of clean and high priced hay.

It is also known that many who have tested his methods have met with failure chiefly because they neglected to supply the young grass plants with a sufficient amount of readily available food for their use in early spring, and before the organic forms of Nitrogen, which exist in the soil only in an insoluble form and which cannot be utilized by the plants as food, are converted into soluble Nitrates by the action of bacteria in the soil. This does not occur to any great extent until the soil warms up to summer temperature when it is too late in the season to benefit the crops' early spring growth.

How Careful Cultivation May Aid in the Profitable Use of Nitrate.

It is important that we always bear in mind the fact that our only source of Nitrogen in the soil for all plants is the remnants of former crops (roots, stems, dead leaves, weeds, etc.) in different stages of decomposition, and that in the early spring there is always

Grass.

1. Without Nitrogen. 2. ⅓ Ration of Nitrogen. 3. Full Ration of Nitrogen.

All three fertilized alike with muriate of potash and acid phosphate.
—R. I. Bu. 103.

a scarcity of Nitrogen in the soil in an available form, for the reason that the most of that which was converted into soluble forms by the action of the soil bacteria during the warm summer months of the previous year was either utilized by the plants occupying the ground at that time or has been washed down below the reach of the roots of the young plants by the melting snow and the heavy rains of late winter and early spring.

When we consider the fact that most plants require and take up about 75 per cent. of their total

Nitrate Ammoniate during the earlier stages of their growth and that Nitrogen is the element most largely entering into the building up of the life principle (or protoplasm) of all plants, it is plain that we cannot afford to jeopardize the chances of growing crops by having only an insufficient supply of immediately available Nitrogen when it is most needed.

Grass.

According to experiments in Rhode Island, soils are less exhausted when complete fertilizers are used with Nitrate than when no Nitrate is used. The soda always left behind after the Nitrate of Soda is used up conserves the lime and potash, and unlocks the soil silicates and thereby frees lime and magnesia. The feeding value of hay is far greater when Nitrate is used as a fertilizer in this connection.

Growing Timothy Hay for Market.

Experiments with Fertilizers,

Highlands Farms, 1904-1906.

Growing hay for market is a subject that is receiving much attention from progressive farmers of late for several reasons, viz:

First, growing hay for market on a portion of the farm is a partial solution of the serious labor problem; since it is much easier to get several hands during the rush of the short haying season than to get good, efficient labor for eight or nine months of the year;

Second, there are usually several fields on nearly every farm in most sections, which, owing to the heavy character of the soil, or for various other reasons, are more suitable for growing hay than for growing the several crops usually grown in a regular rotation;

Third, where the method of seeding down a portion of a large farm to hay has been practiced it has frequently proven that the net profit per year from the smaller acreage devoted to grain and hoed crops, because of the more liberal fertilizing and better cultivation given them, was as great as was formerly obtained from the entire farm, leaving the value of the hay as clear gain over the old method.

The selling price per ton of good Number One Timothy Hay in the markets of America usually ranges between 10 and 20 per cent. higher than that of clover hay, the difference frequently being nearly enough to cover the cost of harvesting and marketing the crop. This, coupled with the fact that the yield per acre of timothy is about equal to that of clover, and it is much easier to cure into good marketable condition, makes it evident that timothy is the more profitable to raise for market in those States where the soil and climatic conditions are favorable.

We have been trying to grow timothy by seeding it with wheat or rye, and smothering it out with the grain crop the first year, and again with clover the second year, until the remaining timothy plants have become so weakened because of these unfavorable conditions and the lack of necessary plant food that they can only make a stunted growth. The result of this general method of growing hay has been an average yield for the whole country of one and one-quarter tons per acre, while, by adopting better methods, it is possible to grow three or four tons per acre and, where conditions are extremely favorable, as much as six tons of timothy per acre can often be grown in one season.

In view of the conditions here pointed out, an experiment was planned in order to determine whether on soils naturally well adapted for hay growing, but out of condition, it is practicable to properly prepare the land and to maintain the meadow so as to secure profitable crops for a period of years by the use of commercial fertilizers alone.

Location of the Experiments and Condition of the Land.

The land upon which the experiments were made is located on the eastern central grazing and dairy plateau of New York, at Highlands Experimental farms. Both river flatland and upland soils were used, making it possible to study both kinds of soil where climatic and seasonal conditions were the same. The character of the flatland is made up of silt, which is of considerable depth and which is still being deposited by means of overflows each spring. It was badly infested with wild sedge grass, and one portion of the meadow had not been harvested for several years. The uplands are more or less rolling, of light loam, not excessively rich in humus, and sometimes affected by droughts.

Preparation of Soil and Seeding.

Preparation for the experiments was begun in 1904; and typical areas were laid off and the land prepared in the best manner.

A method of seeding in this part of the State is to sow timothy in corn at the last cultivation, usually the latter part of July. The corn was planted as early as possible, and just before the last cultivation 20 quarts of timothy seed were used per acre. On the flatland the crop of wild sedge grass was cut early in June, the field plowed, and quite frequently cultivated until about the first of September, when it was carefully seeded at the rate of 20 quarts of timothy per acre.

Two methods of seeding were practiced on the upland; in one case the pasture was plowed early, seeded to oats, and as soon as the crop was harvested, the stubble was plowed, then frequently cultivated, and seeded with 20 quarts of timothy per acre about the 15th of September. In the other case, the pasture land was plowed in June, rolled down and thoroughly and frequently cultivated and similarly seeded about the 24th of September. The latter method, however, did not kill the native grass, and is not recommended.

Fertilizers Used.

Since one object of this experiment was to determine whether profitable cropping could be continued for more than one season, the land was not only thoroughly prepared, but amply supplied with phosphoric acid, potash and lime, in order that there might be no deficiency in the quantity of mineral constituents required for the crop. On the highest and most gravelly portion of the upland, stable manure was applied to supply humus and increase the absorptive power of the soil, and on all the land one ton of lime was applied per acre before plowing; after plowing and rolling, and before harrowing, there was applied to each acre 600 pounds acid phosphate, 200 pounds sulphate of potash, and, in addition to this, the lowland received an application of 740 pounds of basic slag phosphate, and the upland 540 pounds. The Nitrogen was all in the form of Nitrate, and was applied as a top-dressing in the spring.

The following table shows the kinds and amounts of fertilizers that were applied for the crops of 1905 and 1906:

Kind and Quantity of Fertilizers Used Per Acre.

	Upland.		Lowland.	
	1905. Pounds.	1906. Pounds.	1905. Pounds.	1906. Pounds.
Lime	2,000	....	2,000	....
Wood Ashes	....	520	....	520
Acid Phosphate	600	578	600	578
Basic Slag	540	....	740	....
Sulphate of Potash	200	....	200	....
Nitrate of Soda	200	168	200	112

The mineral fertilizers for the crop of 1905 were applied in the fall of 1904, those for the crop of 1906 were applied during the summer of 1905. The Nitrate of Soda was all applied as a top-dressing in the spring, and was evenly distributed as soon as the grass had nicely started. The quantities of Nitrate applied were not as large as is sometimes recommended, but sufficient to provide for a large yield, if fully utilized.

The effect of the thorough preparation of soil was noticeable at once in the good stand of plants secured, and in the vigorous growth and good top made in the fall. The plants wintered well, and after the Nitrate top-dressing had been made the grass on these plots grew luxuriantly, and made a large yield of hay, as is shown in the tabulated statements herewith.

The records include all the items of cost of preparing the land, fertilizing and seeding. This initial cost is relatively high, but since the expectation was to continue experimenting upon grass for a period of years, the cost per annum of preparation, seeding and fertilizing is considerably lessened.

Cost Per Acre of Preparing Upland and Lowland, Seeding and Fertilizing.

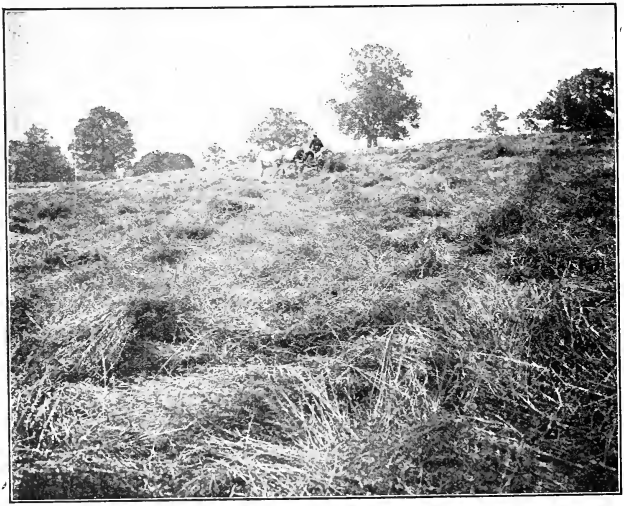
	Cost per Acre. No. Times.	Each Time	Total Cost per Acre. Upland.	Lowland.
Plowing	1	$2.00	$2.00	$2.00
Rolling	3	.20	.60	.60
Pulverizing	8	.75	6.00	6.00
Sowing seed one-half each way	2	.10	.20	.20
20 qts. seed @ $2.60 per bu.	–	1.62	1.62	1.62
Dragging in seed	1	.20	.20	.20
Sowing fertilizers	4	.30	1.20	1.20
2,000 lbs. stone-lime @ $6.50 per ton			6.50	6.50
600 lbs. acid phosphate (14%) @ $14.00 per ton.			4.20	4.20
200 lbs. sulphate of potash @ $50.00 per ton			5.00	5.00
540 lbs. Thomas phosphate @ $13.50 per ton			3.65	——
740 lbs. Thomas phosphate @ $13.50 per ton			——	5.00
Total cost for a 6-year period			$31.17	$32.52
Cost for one year			$5.19	$5.42

This cost of preparation, fertilizing and seeding, which may seem relatively high to farmers who have not been accustomed to so thoroughly prepare the soil or to fertilize so heavily, is really not greater than seeding actually costs when the object is to obtain only one crop. The cost of plowing is the same in any case, and the ordinary preparation, seeding and manuring or fertilizing will make the average cost of seeding nearly as high as is here given for each acre per year. Many farmers will also object to this heavy fertilization with minerals; the answer to this is that if grass is to be seeded down for a series of years, it would be folly not to supply an abundance when it is possible to thoroughly distribute them throughout the entire surface soil, so that the feeding roots reaching everywhere in it may find food, hence the heavy application when seeding down. Later applications must be made upon the surface and can only gradually work down into the lower layers.

The main point, however, is to determine whether it is a paying proposition, and the following tables show the yield and value of crops, as well as the profits derived when mineral fertilizers only are used, and also when Nitrate of Soda is used in addition.

Yield of Crops in 1905.

	Upland.		Lowland.	
	Without Nitrate.	With 200 lbs. Nitrate per acre.	Without Nitrate.	With 200 lbs. Nitrate per acre.
Yield per acre..	3,180 lbs.	8,340 lbs.	6,985 lbs.	8,712 lbs.
Increase from Nitrate.........	5,160 lbs.	162%	1,727 lbs.	24.7%



Crop of Grass Grown by Nitrate Top-Dressing. 1906.

These results are strikingly significant, showing in the first place the difference in adaptability of the two soils for hay growing. The upland was deficient in humus, and being dry and gravelly, was unable to provide Nitrogen in any quantity although an abundance of minerals was present. The lowland, on the other hand, containing a large proportion, was capable of furnishing the Nitrogen needed for a relatively large crop, or more than double that on the upland. This is a very clear illustration of the importance of the use of Nitrogen with minerals, if full crops are to be harvested. The application of Nitrate of Soda on the upland proved much more efficient than on the lowland, not only in supplying Nitrogen in immediately available forms, but in energizing the plants to obtain more from the soil, showing a gain in yield of 162 per cent., while on the lowland the gain was but 24.7 per cent.; the soil itself being able in this case to supply a larger proportion of the Nitrogen required to produce a crop as large as the climatic and seasonal conditions would permit. The main point, however, is not how large a yield may be obtained, but the profits that may be derived. The following table shows the financial results of the two experiments from two standpoints: (1) whether it is profitable to grow hay under the conditions, as outlined here; and (2) whether the use of Nitrate will pay.

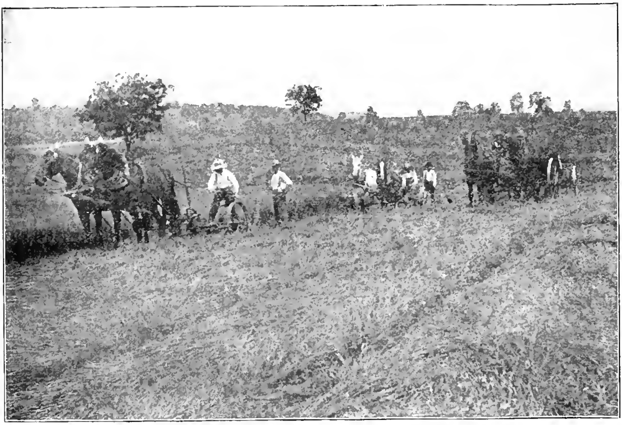
1905.

Cost of Crops.

	Yield lbs.	Preparation and Seeding and Cost of Mineral Fertilizers	Nitrate of Soda	Application of Nitrate	Harvesting	Total	Gross Value of Crop	Net Profit on Crop	Gain from Nitrate
UPLAND:									
With Nitrate...	8340	$5.19	$5.20	$0.30	$8.34	$19.03	$50.24	$31.21	$20.50
Without " ...	3180	5.19	——	——	3.18	8.37	19.08	10.71	
LOWLAND:									
With Nitrate...	8712	5.42	5.20	0.30	8.71	19.63	52.27	32.64	3.14
Without " ...	6985	5.42	——	——	6.99	12.41	41.91	29.50	

The first point of importance shown by this detailed statement is that notwithstanding the expense involved, there is a profit in hay growing; that it pays to expend money for the good preparation of soil, for good seed and for fertilizers—in fact, if the entire cost had been charged to the first crop, there would have been a profit of $5.23 per acre where Nitrate was used on the upland. Second, that it pays to use Nitrate; and third, that the kind of soil to which Nitrate is applied measures in a marked degree the profit to be derived from its application. On the upland, the crop without Nitrate was worth but $19.08 per acre, while the application of 200 pounds of Nitrate caused the value to increase to $50.24 —a gain of $31.16 per acre; deducting the cost of the Nitrate and extra cost of harvesting, we have a net increase in value of $20.50 per acre, or for each dollar invested a net return of nearly $4.00.

On the lowland, the crop without Nitrate was worth $41.91 per acre, and, with Nitrate, $52.27, a gain of



The Tedders follow the Mowing Machines for rapid curing of heavy crops of hay.

$10.36, which is reduced to $3.14 when the cost of Nitrate and harvesting is deducted, still a good profit on the investment, though clearly indicating that Nitrogen was not the limiting factor in crop production as was the case on the upland. In making the tables, the actual cost of labor, seed and fertilizers was used. The value of the hay was estimated at $12.00 per ton, and based on weights at time of harvesting. The shrinkage of hay will range from 15 to 25 per cent.; assuming the shrinkage to be as unusually high as 25 per cent., the value per ton would have to increase to $16.00 to balance, which is lower than prevailing prices have been since that year for No. 1 Timothy.

Crops of 1906.

The experiment was continued in 1906, on the same areas. In order to insure a constant and abundant supply, mineral fertilizers were again added in the form of wood ashes and acid phosphate, and in the amounts shown in the table, namely, 520 pounds of wood ashes and 578 pounds of acid phosphate per acre on both the fields.

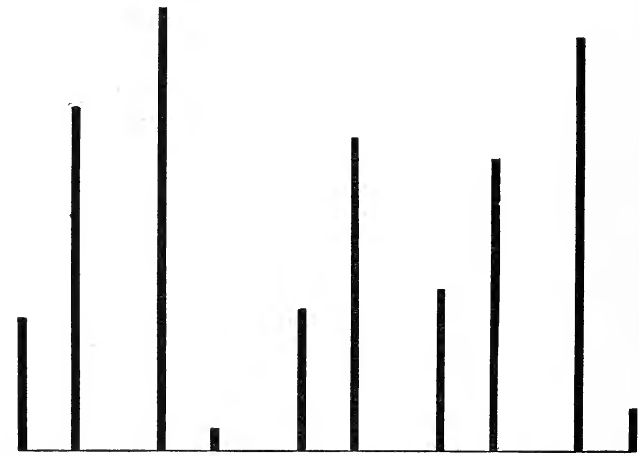
The applications of Nitrate were, however, reduced from 200 to 168 pounds on the upland; and to 112 pounds on the lowland per acre. These fertilizers were all evenly distributed in the spring of 1906. The effect of the Nitrate was again immediately noticeable in increasing the vigor of the plants. The yields were as follows:

Yield of Crops in 1906.

	Upland.		Lowland.	
	Without Nitrate.	With 168 lbs. Nitrate per acre.	Without Nitrate.	With 112 lbs. Nitrate per acre.
Yield per acre.......	3,200 lbs.	6,240 lbs.	5,920 lbs.	8,080 lbs.
Increase from Nitrate	3,040 lbs.	95.0%	2,160 lbs.	36.4%

These results confirm those for 1905 on the whole, though there are points of difference which may be reasonably charged to season and to the effect of the growth of the first crop. On the upland, which was poor in humus and Nitrogen, the yield of the plot without Nitrate differs but little from that of 1905, while on the lowland, the soil rich in humus, the yield without Nitrate is much lower than in 1905. On the upland the Nitrogen at the disposal of the plant did not exist in easily changeable forms, and hence was not largely exhausted under the energy of the extra mineral food. The lowland, on the other hand, doubtless contained considerable Nitrogen in easily changeable forms, which under the stimulus of the available phosphoric acid and lime was made effective on the grass, and resulted in a comparatively large yield, leaving the soil much poorer in Nitrogen for the next crop.

It would appear from this reasoning, that the need for applied Nitrogen, while greater for the upland in 1905 than in 1906, is not so striking as in the lowland. This assumption is borne out by the facts; the gain on the upland in 1905 is 3,040 pounds, or 95 per cent., as against a gain of 5,160 pounds, or 162 per cent. in 1906; while the gain on the lowland is 36.4 per cent. in 1906, as against 24.7 per cent. in 1905. The lower



percentage increase in yield from Nitrate on the upland being due in part, at least, to the fact that the Nitrate used in 1905 energized the plants to acquire more from soil sources than was possible with the use of minerals only, and in part to the lower quantity applied in 1906, 168 pounds instead of 200 pounds.

On the lowland the greater percentage increase this year, due to Nitrate, is for the same reason that it was greater in 1905 on the upland than in 1906. This is a clear demonstration again of the influence of character of soil as a determining factor. Instead of reducing the amount of Nitrate used in 1906, it should have been increased, especially on the upland. The value of crop and profits are also influenced by the smaller amounts of Nitrate applied, as shown in the comparative profits in the tabulated statement.

1906

Cost of Crops.

	Yield lbs.	Preparation and Seeding	Mineral Fertilizers and Nitrate	Application of Fertilizer	Harvesting	Total	Gross Value of Crop	Net Profit on Crop	Gain from Nitrate
UPLAND:									
With Nitrate...	6240	$5.19	$12.60	$0.90	$6.24	$24.93	$37.44	$12.51	$10.20
Without " ...	3200	5.19	7.90	.60	3.20	16.89	19.20	2.31	
LOWLAND:									
With Nitrate...	8080	5.42	11.04	.90	8.08	25.44	48.48	23.04	7.36
Without " ...	5920	5.42	7.90	.60	5.92	19.84	35.52	15.68	

In making up this table, the actual cost of labor and fertilizers is recorded, while the value of dry hay was estimated to be $12 per ton when stored, as in 1905.

As a whole, the results confirm those of 1905 in showing a profit in all cases, ranging from $2.31 per acre, without Nitrate, on the upland; to $23.04 with Nitrate, on the lowland. It is to be expected from the preceding discussion that the relative profits from the use of Nitrate on the two areas is changed, the net profit of $20.50 on the upland being reduced to $10.20, and that of $3.14 on the lowland being increased to $7.36 per acre. These net results, secured under what would be regarded as expensive methods, are certainly satisfactory from a financial standpoint, and indicate that on lands requiring expensive treatment hay growing may be made profitable, and warrant the following general suggestions as to the growing of profitable crops:

The essential conditions necessary for obtaining maximum crops of timothy are, first, a clean, thick stand of healthy timothy plants; second, an abundance of available plant-food is needed by the plants to make a normal growth.

It must not be overlooked that available plant-food at the right time implies that there shall be sufficient moisture present in the soil to carry the plant-food into the roots of the plants in a soluble form; and just in proportion as we fail to have a sufficient supply of moisture present when needed, we render our supply of plant-food unavailable as far as plant growth is concerned. Thus, it is well known that very frequently the limiting factor in the growth of plants is a lack of sufficient moisture in the soil at a critical time rather than a deficiency of actual plant-food in the soil.

For this reason it is best to select those portions of the farm for growing timothy, in which the soil is rather heavy and retentive of moisture. When there is a supply of stable manure available for use in hay growing, it should, whenever possible, be plowed under or otherwise worked into the soil before seeding, and not be used as a top-dressing on meadows already seeded, for the reason that the chief value of stable manure is that it adds large quantities of humus-making material to our soils, and *the soils need their humus in them and not on them.* For similar reasons stable manure should be applied to those soils most deficient in humus and not to the muck lands and those that are naturally moist.

Preparing Land.

The river-bottom lands, because of their silt formation and the added fertility which they receive in their annual overflow, together with their abundant supply of moisture during the entire season, are able to produce the largest crops of timothy, at the lowest cost per ton, but these soils are usually very foul with quack, sedges and wild grasses, which must be largely eradicated, in order to get a stand of clean timothy.

Where there are stumps or rocks that would interfere with the operations of haying machinery, it is advisable to remove them wherever possible, and it was found that the judicious use of dynamite effected a great saving in the time and expense of this operation.

After plowing, the land should be rolled and then thoroughly worked every week or ten days up to seeding time. The field should be worked in small lands, going around each land, and always lapping the harrow one-half, so that the surface may be kept level.

If there are any deep holes in the field, resulting from the removal of boulders or other cause, they should be filled in at the time of the first harrowing, and if there are any surface ditches they should be made shallow with gradually sloping sides, wherever possible, so that the entire surface of the field can be gone over with a mowing machine in any direction when the hay crop is to be harvested.

The difference in the expense of preparing a field right, or only partially so, is very slight, when considering possible breakage of machinery when harvesting the crops of several years, figured on the basis of low cost per ton of product, and this factor is of double importance in the preparation of land on which it is possible to harvest two crops each season.

Liming.

It is known that timothy cannot thrive and yield maximum crops in a sour soil, while red-top seems to delight in such soil, and one of the surest indications that a soil is sour is when we find the timothy meadow run out after two or three years and the ground occupied by red-top. The presence of sorrel, five-finger, mosses, daisies and mulleins are also indications of a sour soil, and timothy cannot be made to do its best on those soils until they are made sweet. The quickest and most practical way to accomplish this is by the liberal application of lime in some form. This may be applied in the form of stonelime, either ground or unground, or air-slaked; or in connection with potash in wood ashes. The amount of lime to apply should be generally about one-half ton per acre.

If we use lime in the form of ashes or ground stone-lime, it can be drilled into the soil at the right depth with a fertilizer drill, but if we use air-slaked lime or lump lime and slake it in the field, it should be spread either before plowing or immediately after the first harrowing and before the ground is rolled, so that the bulk of the lime will get down into the soil at the right depth.

Mineral Fertilizers.

This question of the correct application of the mineral elements of plant-food is of great importance, and has not received the consideration it deserves—especially is this so in regard to fertilizing meadows or grass lands, which usually remain seeded down for several years, and there is no time after the seed is sown that the phosphoric acid and potash can be gotten down into the soil where they belong, which place is from three to six inches under the surface. When phosphoric acid or potash are used as a top-dressing for meadows, it is known that they become fixed largely in the surface and consequently tend to attract the feeding roots of the plants to the surface of the soil, where they are least able to withstand the effects of drought, which is so often such a serious factor.

The amount of phosphoric acid and potash to be used depends upon the soil entirely, and can only be approximated, but the fact that they both become fixed in the soil so that there is practically no danger of loss from one season to another, allows us to be more liberal than we otherwise would, and since the best time to apply it is before the seed is sown, we should be liberal in regard to the quantity used for obvious reasons.

For good, medium-clay land of average fertility, there should be drilled into the soil broadcast, at least 300 pounds per acre of 16 per cent. acid phosphate and 300 pounds of ground bone, also 150 pounds per acre of sulphate of potash or its equivalent, and if the soil is a poor, sandy or gravelly soil, or a peaty or muck soil, which are known to be usually deficient in these elements, the quantity of each should be doubled. Remember when it comes to fertilizing our crops, the question we should ask ourselves is not "how much will it cost me to furnish my crop with the food that it needs?" but "how much will it cost me *not* to do so?"

Acid phosphate appears to be the safest and the best form in which to apply phosphoric acid to soils for hay growing generally.

High-grade sulphate of potash is one of the most satisfactory of the commercial potash salts and its use does not tend to deplete the soil of its lime as does the use of muriate of potash. The phosphoric acid and potash should be applied to the soil broadcast to the depth of at least three inches from one to two weeks before sowing the seed. Hard-wood ashes are excellent when not adulterated, as a source of potash and lime.

Seeding.

Twenty quarts per acre of the best recleaned timothy seed obtainable is the right quantity to sow per acre, and this should be sown between August 15th and September 15th, the time that timothy naturally reseeds itself. It can best be sown with a wheelbarrow, broadcast grass seeder, sowing ten quarts each way of the field for most even distribution, after which the seed should be dragged into the soil about one inch deep, by going over the field once or twice with a slant-tooth drag or a weeder with sufficient weight attached to obtain the desired result.

Finish the operation by going over the field with a roller, to roll down the loose stones on the surface and to compact the surface soil, thus bringing the moisture to the surface so that the seed will all germinate at once and come up evenly over the entire field.

Nitrate Application.

So far we have insured a good, clean, thick stand of healthy timothy plants, and we have supplied them liberally with the mineral plant foods that are liable to be deficient in the soil, but we have made no provision for the plants having an abundant supply of available Nitrogen the next spring when they are making their most rapid growth, and their need is greatest. At that time there is always a scant supply of soluble Nitrogen in the surface soil, owing to the fact that when the excess moisture settles down into the lower levels of the soil it carries Nitrogen in solution with it, and the stores of humus Nitrogen are not rendered soluble, except in very slight amounts, until the soil warms up to a degree of temperature wherein the soil bacteria again become active and convert organic and other forms of Nitrogen into Nitrates.

To overcome this natural deficiency of soluble Nitrogen at a critical time in the growth of the timothy plants, we must supply it in an available form, and this can best be done by applying broadcast about 100 to 200 pounds of Nitrate of Soda per acre as a top-dressing as soon as the excess moisture has settled down out of the surface soil and growth starts in the spring, between April 10th and May 10th, in our principal hay growing States.

In other words, as Professor Thomas F. Hunt puts it, in Cornell University Experiment Station Bulletin, No. 247, p. 203:

"Having water-soluble Nitrogen on tap at the right hour and the right place is *one* of the factors that enabled the Cornell Station to grow three and one-half tons of timothy hay on Dunkirk clay loam, when without this artificial help only about one and one-half tons could be raised."

Report of Experiments.

Season of 1906.

Highland Experimental Farms, New York.

The average yields per acre of field-cured hay on the uplands were as follows:

No Nitrate—3200 pounds per acre.
168 lbs. Nitrate—6240 pounds per acre.

The average yields per acre of field-cured hay on the lowlands were as follows:

No Nitrate—5920 pounds per acre.
112 lbs. Nitrate—8080 pounds per acre.

Comparison of Yields, 1905 and 1906.

Uplands.

Season.		
1905.	No Nitrate—3180 lbs.	300 lbs. Nitrate—8340 lbs.
1906.	No Nitrate—3200 lbs.	168 lbs. Nitrate—6240 lbs.

Lowlands.

Season.
1905. No Nitrate—6985 lbs. 200 lbs. Nitrate—8712 lbs.
1906. No Nitrate—5920 lbs. 112 lbs. Nitrate—8080 lbs.

Yield of original "No Nitrate" hollow square plot in field of timothy and red top:

Season of 1905—3180 lbs.
Season of 1906—1760 lbs.

The yields are lower for 1906 than for 1905 owing to smaller applications of Nitrate and probably also to the fact that there was much less rainfall during the growing season.

Experiments with Nitrate of Soda on Oats and Peas for Hay.

Highlands Farms, 1907.

The original purpose of this experiment was to study the effect of the application of different quantities of Nitrate of Soda upon the yield of oats and peas as a preparatory crop for seeding the land to permanent meadows. The character of the soil has already been described on previous pages; it is not rich in humus, and thus not highly productive, without the application of manures or of Nitrogen in some soluble form. The location is such as to furnish excellent natural drainage, and to enable the land to be rapidly improved by proper methods of culture and fertilization. Since the land was intended to serve as an experimental field for the growing of hay, it was well supplied at time of seeding with the mineral elements, viz.: 500 pounds per acre of an even mixture of ground bone, acid phosphate and sulphate of potash; this was applied broadcast, and harrowed in previous to seeding the oats and peas. The land was thoroughly prepared early in the spring, though owing to the lateness of the season the planting was not made until May 1.

The plots were one-tenth of an acre in area, long and narrow, and each plot separated from the other by five-feet strips of land, which were kept cultivated and free from weeds. The scheme for treatment was as follows:

Plot	Treatment.	Minerals.
1	Nitrate of Soda	10 pounds.
2	Nitrate of Soda	15 pounds.
3	Check	Minerals only.
4	Nitrate of Soda	20 pounds.
5	Nitrate of Soda	25 pounds.
6	Check	Minerals only.
7	Nitrate of Soda	30 pounds.
8	Nitrate of Soda	35 pounds.

Since, as already stated, the primary purpose in the planning of the experiment was to have the land seeded down with grass immediately after the oats and peas were removed, the use of the larger quantity of Nitrate was made in order to study the question whether the residual Nitrate from the large application would be of service in hastening the germination and early growth of the grasses that were to be seeded.

Owing to circumstances which prevented the carrying out of this object, the study herewith includes only the effect of the different quantities of Nitrate upon the oat and pea crop. The mineral fertilizer was applied immediately after plowing, and thoroughly harrowed into the soil over the entire area; the Nitrate was next applied, and the seed, at the rate of one and one-half bushels each of oats and peas per acre, broadcasted upon each plot and harrowed in.

Careful records were kept of the appearance of the plots during the growing season; up to June 26, no apparent difference was noticeable in the appearance and size of the plants on the different plots. On July 3 there was a noticeable difference in the color, thickness and height of the crops, and measurements showed the plants on plots 1, 2, 3 and 6, to be 10 inches high, and of a medium green color, fairly vigorous. On plots 4 and 5, the oats were noticeably taller, while upon plots 7 and 8, there was a very marked increase in size and in the appearance of the crop, averaging 14 inches as against 10 inches upon the four plots, and 12 inches upon plots 4 and 5.

Observations were taken thereafter each week until the crop was harvested, Aug. 23. These differences in appearance held throughout, becoming more striking as the season advanced. For example, on July 24 and Aug. 7 the following observations were made:

July 24th.

Plot		Inches.
1	Oats and peas	32, fair color, uneven, very few peas.
2	" "	34, dark color, even, very few peas.
3	" "	28, a little yellow, uneven.
4	" "	38, very dark color, even.
5	" "	38, very dark color, even.
6	" "	28, fair color, uneven, very few peas.
7	" "	40, very dark color, and even over the whole plot.
8	" "	40, very dark color, and even over the whole plot.

N.B. Plots Nos. 4, 5, 7 and 8 are much heavier, darker in color and are very even—there is a greater number of peas and they are in fine condition in these plots. Noticed some rust on all the plots. On plots Nos. 1 and 6 the few peas there are seem to be drying up.

August 7th.

Plot		Inches.
1	Oats and peas	37, uneven, very few peas with no pods.
2	" "	39, even, few peas.
3	" "	31, uneven, few peas with no pods.
4	" "	42, very even, plenty of peas.
5	" "	42, very even, plenty of peas.
6	" "	32, uneven, very few peas.
7	" "	44, very even over whole plot.
8	" "	44, very even over whole plot.

N. B. Same conditions prevail as last week with every plot except that the straw is beginning to change its color. Plots Nos. 4, 5, 7 and 8 are somewhat greener than the rest, with plenty of peas of good color, and with well-filled pods. Peas in plots Nos. 1, 2, 3 and 6 seem to be drying up, the few there are.

After Aug. 7, when the limit of growth had been reached, no changes were observed in the appearance of the plots; on Aug. 21, the crops were harvested, and on Aug. 23 the field-cured crops on the different plots were weighed and stored, with weights per plot as follows:

Plot.		
1	Hay	320 pounds.
2	"	320 "
3	"	210 "
4	"	385 "
5	"	460 "
6	"	290 "
7	"	540 "
8	"	550 "

The first point requiring particular notice is the variation in the proportions of oats and peas on the different plots. It is quite evident that the peas must have drawn their Nitrogenous food from the soil rather than from the air. While this difference in proportion of oats and peas would make a difference in the quality of the hay for feeding, it probably would not make any difference in the price that would be received for it as hay. The oat and pea crop is not generally grown for market, but for use upon the farm and is an especially valuable crop upon farms devoted largely to the growing of hay for market, because furnishing food for stock, and thus enabling the disposal of the high-priced hay, though really less useful as feed.

The second point to be observed is that the Nitrate increased the yield of crop in every instance above that obtained on the check plots, and while the yields upon the check plots are lower than upon any of the Nitrated plots, that upon plot 6 is much higher than upon plot 1, and this can be explained on the ground that, owing to the larger application upon plots Nos. 5 and 7, there may have been some feeding upon the adjoining crops, as the records show that up until the week of July 24, no differences were discernible in the height and the appearance of the oats upon the two plots, but after that date the crop on plot 6 began to improve. The average, however, of the two plots is so much lower than upon any one of the others as to make the comparison a safe one for study.

The following table has been prepared to show the increase in yields upon the various plots, as compared with the average of the two check plots:

Table I.—Yield of Oat and Pea Hay.

Plot		Yield per Plot. Pounds.	Yield per Acre Total. Pounds.	Increase due to Nitrate. Pounds.
1	Minerals + 100 lbs. Nitrate of Soda,	320	3,200	700
2	" + 150 " "	320	3,200	700
3	" only....................	210	2,100	....
4	" + 200 lbs. Nitrate of Soda,	385	3,850	1,350
5	" + 250 " "	460	4,600	2,100
6	" only....................	290	2,900	....
7	" + 300 lbs. Nitrate of Soda,	540	5,400	2,900
8	" + 350 " "	550	5,500	3,000

It is very evident from a study of this table that Nitrogen was essential in order that a larger crop might be secured, for, although a reasonably liberal dressing of minerals was applied upon the entire area, those plots upon which no Nitrogen was applied showed a very much lower yield than on any of the other plots, though probably quite as high as is obtained on the average from what is regarded in that section as fairly good hay land. The increase, however, was very marked from the addition of Nitrate, and is practically in proportion to the amount added until a dressing of 300 pounds per acre is reached. That is, it is shown that not only is Nitrogen needed, but the conditions of soil and of season were such as to enable the plant to utilize the Nitrogen almost completely when as heavy a dressing as 300 pounds per acre was used, increasing the total tonnage from 1¼ to nearly 2¾ per acre.

A study of this utilization is interesting. Assuming the average composition of Nitrate of Soda to be 15.5 per cent. Nitrogen, and taking the average content of protein in oat and pea hay, which for even mixtures of oats and peas is 10.31 per cent. equivalent to 1.65 per cent. Nitrogen, we find the following results:

Plot	Applied	Increased Yield.	Recovered in crop.
1	15.5 lbs. Nitrogen.........	700 lbs.	11.55 lbs.
2	23.2 "	700 "	11.55 "
4	31.0 "	1,350 "	22.28 "
5	38.8 "	2,100 "	34.65 "
7	46.5 "	2,900 "	47.85 "
8	54.5 "	3,000 "	49.50 "

Not only was the Nitrogen utilized well on practically all of the plots, but at the prices which prevailed for hay and feed during the season, the increased yield from the larger applications proved to be more profitable than those of the lower. In other words, the complete utilization of Nitrate does not necessarily mean that there shall be a proportionate profit derived, as the profits will increase in a greater ratio, when the same ratio of utilization is maintained in the larger application. This is very clearly shown in the table of gross and net values of crops, due to the application of Nitrate.

Table II.—Gross and Net Values of Crops.

Plot	Value of Crop.	Increase in Value of Nitrated Crop.	Cost of Nitrate.	Net Value of Increased Crop.
1	$22.40	$4.90	$2.60	$2.30
2	22.40	4.90	3.90	1.00
3	17.50	....	....	....
4	26.95	9.45	5.20	4.25
5	32.00	14.50	6.50	8.00
6	17.50	....	....	....
7	39.80	22.30	7.80	14.50
8	40.50	23.00	9.10	13.90

Although the markets do not recognize oat and pea hay in their classification, and thus establish a market value, nevertheless its feeding value is recognized, and its use upon the farm must have a direct bearing upon the net profits that may be derived from the growing of marketable hay, as it increases the quantity that may be sold.

At the prices received for hay the past season, $14 per ton for well-cured oat and pea hay, would be regarded as a fair price. It will be observed that on this basis the gross value of the yields on the different Nitrated plots range from $22.40 for plots 1 and 2, to about $40 per acre for plots 7 and 8, an increase of about 80 per cent., or a gain in value of increased crop ranging from $4.90 to $23 per acre. Deducting the cost of the Nitrate of Soda applied, the net increase in value of crops ranges from $1 on plot 2 to $14.50 on plot 7, or an increase in net value of crop on plot 7 of more than seven times as much as the average of plots 1 and 2. All were profitable, although the limit of net profit was reached with an application of 300 pounds per acre. That is, it seems that beyond that point the season and climatic conditions rather than Nitrogen became the limiting factors, when soils were supplied with enough phosphoric acid and potash. The application of Nitrate of Soda was profitable in all cases, though varying with the amounts applied.

The farmer naturally desires to secure the greatest net profit. On land of this sort, therefore, it would be necessary for him to apply 300 pounds per acre; for a large field this dressing would seem to be rather expensive, taking into consideration the possible risk due to unfavorable seasons. In many cases, too, the productive power of the soil may be greater than was here found to be the case, when a less quantity of Nitrate of Soda would meet the needs of a maximum crop.

The experiment gives suggestions on this point, also. Averaging the yields obtained from the use of Nitrate, it is found that the application of 100 pounds of Nitrate increased the yield by nearly 800 pounds. Taking this to be a fair guide, as to what may be expected from the application of Nitrate, the amounts to be applied would be in proportion to the difference between what the farmer estimates to be his average yield and the possible production in his neighborhood. For example, assuming that the average yield would be 3,000 pounds, without Nitrate, and the maximum yield 5,000 pounds with Nitrate, an application of 250 pounds per acre would enable him to reach his maximum yield. If, on the other hand, his estimated yield, without Nitrate is 2,000 pounds, and his estimated maximum is 3,000 pounds, then the application of 125 pounds of Nitrate of Soda per acre would supply all the needed Nitrogen to make this yield. In either case, the Nitrate would be used to quite as good advantage, as was shown in this experiment, and the results profitable in both cases, though, as in the experiment, the larger yield would give the largest net returns. It is more than likely that on average soils an application ranging from 125 pounds to 200 pounds of Nitrate of Soda per acre would be apt to meet the maximum requirements. Hence, in practice savings may be effected if the farmer is careful to study his range of yields for a period of years, without manure, as well as the range of yields under high fertilization, in order to determine the most economical amount of Nitrate to apply.

The main results, however, lead to the conclusion that Nitrate of Soda is a most useful form of Nitrogen for oat and pea forage, and that it pays directly even on relatively low-priced crops to apply as high as 300 pounds per acre, and indirectly in permitting of the sale of a larger quantity of marketable hay at high prices.

Field Experiments with Nitrate of Soda at Highlands Farms 1908.

In the spring of 1908, other experiments were planned and carried out for the purpose of studying two fundamental questions:—First, whether it would pay to use Nitrate of Soda; and second, whether it would pay to make more than one dressing. It was also planned that the applications of Nitrate should be such as to encourage the practical farmer to begin its use—that is, not to use a larger dressing than he would be willing to purchase, and thus make the work educational in two directions.

Six experiments were planned with the following crops:—

Oats and peas	Timothy hay
Oats	Field corn
Barley	White potatoes

and in each experiment six plots, one-tenth of an acre in area, were used; these plots were separated by strips five (5) feet wide, which were cultivated and kept free from weeds.

In all cases, except for potatoes, the following mineral fertilizer was applied at the rate of 300 lbs. per acre, spread broadcast and well harrowed into the soil:—

Ground bone	100	lbs.
Acid phosphate	200	"
Sulphate of potash	100	"

and for potatoes 300 lbs. per acre of the following mixture was broadcasted:—

Ground bone	100	lbs.
Acid phosphate	350	"
Sulphate of potash	250	"

and at the time of planting 400 lbs. per acre was well distributed in the row. The amounts of Nitrate and the method of application for the different crops were as follows:

Plot	Treatment	Minerals + lbs. per plot	Applied
		Oats and Peas.	
1	Nitrate of Soda	10	When seeded.
2	Check	Minerals only	
3	Nitrate of Soda	10	One-half at time of seeding; balance 3 weeks later.
4	Nitrate of Soda	15	When seeded.
5	Check	Minerals only	
6	Nitrate of Soda	15	One-half at time of seeding; balance 3 weeks later.
		Oats.	
1	Nitrate of Soda	10	When seeded.
2	Check	Minerals only	
3	Nitrate of Soda	10	One-half at time of seeding; balance 3 weeks later.
4	Nitrate of Soda	15	When seeded.
5	Check	Minerals only	
6	Nitrate of Soda	15	One-half at time of seeding; balance 3 weeks later.
		Barley.	
1	Nitrate of Soda	15	When seeded.
2	Check	Minerals only	
3	Nitrate of Soda	15	One-half at time of seeding; balance 3 weeks later.
4	Nitrate of Soda	20	When seeded.
5	Check	Minerals only	
6	Nitrate of Soda	20	One-half at time of seeding; balance 3 weeks later.
		Timothy Hay.	
1	Nitrate of Soda	15	When grass is well started.
2	Check	——	
3	Nitrate of Soda	15	One-half as soon as grass is well started; balance 3 weeks later.
4	Nitrate of Soda	20	When grass is well started.
5	Check	——	
6	Nitrate of Soda	20	One-half as soon as grass is well started; balance 3 weeks later.
		Field Corn.	
1	Nitrate of Soda	15	When planted.
2	Check	Minerals only	
3	Nitrate of Soda	15	10 lbs. when planted; 5 lbs. at first cultivation.

Plot	Treatment	Minerals + lbs. per plot	Applied
4	Nitrate of Soda	15	7.5 lbs. at first cultivation; 7.5 lbs. at third cultivation.
5	Check	Minerals only	
6	Nitrate of Soda	15	7.5 lbs. at time of planting; 7.5 lbs. at third cultivation.

White Potatoes.

1	Nitrate of Soda	20	At time of planting.
2	Check	Minerals only	
3	Nitrate of Soda	20	One-half at time of planting; one-half broadcast at first cultivation.
4	Nitrate of Soda	25	At time of planting.
5	Check	Minerals only	
6	Nitrate of Soda	25	One-half at time of planting; balance at first cultivation.

Corn.

Corn in Ear—24 Bushels.

Average product per half acre for U. S. of Corn with average farm fertilization.

Corn in Ear—56 Bushels.

The product of half an acre of corn fertilized with Nitrate of Soda, home mixed with Phosphate and Potash.

The land in all cases was similar to that already described for the highlands, namely, naturally good soil, but deficient in physical character or in humus.

With the exception of timothy, the crops were all planted at such times in the spring as was deemed most satisfactory: timothy hay being seeded in the previous year. In all of the experiments, the germination of seed was good, and conditions were favorable for a brief period only, as one of the worst drouths in many years prevailed throughout the entire season. In fact, but little rain fell from the first of May until after the crops were harvested, or practically from the time the crops were planted until they were harvested.

Naturally, the results of the experiments were exceedingly variable, and thus less satisfactory than if the seasonal conditions had been nearer the average. The records are as follows:

Oats for Hay Forage.

Plot.	Yield per Plot, Hay. lbs.	Yield per Acre, Hay. lbs.	Gain in Yield from Nitrate. lbs.
1............	320	3200	900
2............	230	2300	...
3............	310	3100	800
4............	280	2800	500
5............	230	2300	...
6............	410	4100	1800

It will be observed that the yields were not large. The oats were cut when the grain was in the dough state and straw still green, or in the most suitable state for hay. Under average seasonal conditions, the yields should have been at least 50 per cent. higher. Nevertheless, the value of Nitrate is very clearly shown in all cases, and reasonably uniform, except in the case of plot 6.

The percentage gain on the different plots range from 21.5 per cent. on plot 4, to 78.3 per cent. on plot 6. The average for the whole being 43 per cent. increase, or an average gain per acre of 1,000 lbs. of dried oat hay.

These experiments show very clearly, therefore, that even in seasons of excessive drouths, the Nitrate contributes very materially to the yield of crop and to profit. Oat hay, while not ordinarily a marketable crop, was worth on the farm at that time, in comparison with other marketable hays, $18 per ton, hence the average increase in yield would be worth $9, which, less the cost of Nitrate applied, would leave a net profit of $5.25 per acre; only on plot 6 was the Nitrate utilized to the fullest advantage, or the Nitrogen usually available from Nitrate of Soda secured in the crop. The increased crop on plot 6 would be worth, on the same basis as the average, $16.20, or a net profit for each acre of $12.45, which corresponds with the increase which should, and probably would have been obtained in an average season.

2. Timothy Hay.

As was the case with oats, the season was such as to prevent normal development—there was only one light rain after the first application of Nitrate was made, and

Forage Corn.

300 lbs. Acid Phosphate.
100 lbs. Sulphate of Potash.
150 lbs. Nitrate of Soda.
Yield, 20 tons of green forage corn per acre.

300 lbs. Acid Phosphate.
100 lbs. Sulphate of Potash.
Yield, 9½ tons of green forage corn per acre.

none after the second application. The records are as follows:—

Plot.	Yield per Plot. lbs.	Yield per Acre. lbs.	Gain from Nitrate per Acre. lbs.
1.	780	7800	2575
2.	575	5750	. . . .
3.	745	7450	2225
4.	770	7700	2475
5.	470	4700	. . . .
6.	680	6800	1575

The yields were good, notwithstanding the season; the average yield on the unfertilized plots being over two and one-half tons per acre, and although there was a large variation in the yields of the two check plots, it was not so great as to vitiate the results obtained, as the differences between the yields of the two check plots was not as great as the difference between the lowest yield on the fertilized plot and the average of the check plots.

The increase in yield ranged from 1575 to 2575 pounds, or an average for all of the plots of 2212 pounds, or over one ton per acre.

No special influence was observed, either from the larger application or from the method of application—the one application, made at the time the plants had well started, under the conditions prevailing this year, gave the largest yield. This was to be expected, owing to the fact that after the second application there were no rains to distribute the Nitrate. Deducting the cost of Nitrates, the net profits ranged from $4.45 to $11.70, or an average of $8.70 per acre. The hay was valued at $12 per ton, as stored in the barn; the average loss in the barn was 18.5 per cent. Inasmuch as barn-cut hay was selling at $14 per ton, the valuation of $12 was fair for this season. This experiment, while not as illuminating as would have been the case if the seasonal conditions had been good, still verifies the conclusions arrived at from the results obtained in previous experiments, namely, Nitrate of Soda is one of the most important, useful and valuable forms of Nitrogen to use, and the most profitable form to use as a top-dressing for grass fields in the spring.

Oats and Peas for Forage.

The experiment with oats and peas suffered in common with the others, due to the season, although apparently in a greater degree, as the hot weather affected the growth of the peas to a greater extent than it did the oats alone. Unfortunately, through an error, the crop on plot 1 was harvested before the others, and no record was made of it. Discarding this, we find the yields to be as follows:—

Plot.	Yield per Plot. lbs.	Yield per Acre. lbs.	Gain from Nitrate per Acre. lbs.
1............	...	....	....
2............	250	2500	....
3............	350	3500	1100
4............	330	3300	900
5............	230	2300	....
6............	290	2900	500

The yields were not large, and were quite variable—the average on the check plots being but slightly in excess of 1 ton per acre. The increase in yield from the use of Nitrate of Soda ranged from 500 to 1,100 lbs. per acre, or an average of 834 lbs., an increase of about 60 per cent. Hence, notwithstanding the unfavorable seasonal conditions, a profit was secured, the average net profit at $12 for hay being $1.85 per acre, or for each dollar invested there was a return of nearly $1.60.

Corn, Potatoes and Barley.

The crops of corn, potatoes and barley, on the other experiments, although they grew well in the beginning, were a failure, owing to the continued drouth. There was practically no moisture in the soil when the crops on the other experiments were harvested, at which time the corn and potatoes were in the greatest need of moisture—the corn to enable it to develop and form ears and the potatoes to set tubers and to provide for their growth.

Fertilizing Hay Crops in California.

In the West Coast States wheat is sown for hay, and cut green; likewise oats.

The experiments with fertilizers on oats-hay crops by the California Experiment Station, begun in 1901, were continued during the season of 1902-3. During the season of 1901–2 it was found that the use of Thomas phosphate slag and sulphate of potash with Nitrate of

Soda did not pay as well as Nitrate of Soda used alone. The experiments during the last season were planned to test the availability of the phosphate after the first season. It was thought that there was a possibility that the insoluble slag phosphate would become more available the second season after applying it. The plots first used in the experiments were subdivided and given different applications of Nitrate of Soda, used alone and in combination with sulphate of potash at the rate of 300 pounds per acre.

The yield of hay was lower on both fertilized and unfertilized plots during the second season than it was in the first. This difference is undoubtedly due to an unfavorable season. The late spring rainfall failed almost entirely, and to this, no doubt, must be attributed the decreased yield.

An inspection of the summary of results shows that the heaviest yields of hay on both red and granite soils and the largest money returns per acre were obtained from the plots which were fertilized with phosphate during 1901–2. On red soil with oats-hay the gain from the use of Nitrate of Soda on the plot which had phosphate the year previous was $11.70 per acre, as against only $3.72 per acre where the Nitrate was used on land having no previous fertilization.

On granite soil with oats-hay there was no gain from the phosphate. The use of Nitrate of Soda alone without previous fertilization yielded $9.44 per acre profit, while on the plots having phosphate applied the previous year, the gain was only $5.74 per acre.

In 1903 the heaviest yield of hay was obtained from oats, and the largest profit per acre from wheat on granite soil which had an application of Thomas slag, sulphate of potash, and lime, in 1902. Nitrate of Soda was used at the rate of 320 pounds per acre in 1903. The yield of hay was 5,772 pounds per acre, and the resulting profit $12.89 per acre. It should be remarked here, however, that this plot was fertilized at a loss of $21.50 per acre in 1902; and as the application of Nitrate was larger than was used on any other plot, the increased returns were at least partly due to the increased supply of the Nitrate.

The use of sulphate of potash in combination with Nitrate of Soda, on granite soil, did not pay in 1903. Potash was used at the rate of 300 pounds per acre. In most cases the fertilizer cost more than the increased crop of hay; hence its use incurred a loss of from 76 cents to $4.57 per acre.

The experiments with Nitrate of Soda used alone were broadened in 1903 to test the efficacy of different amounts per acre and the division of the application into two doses. The results show that in 1903, 160 pounds of Nitrate of Soda per acre in one application yielded the largest profits viz.: $9.44 and $8.90 per acre, respectively, on two plots on granite soil. In all cases the yield was reduced when the fertilizer was put on in two applications; thus, with 160 pounds per acre applied in two doses, only $4.82 and $7.27 per acre were yielded by two plots on granite soil.

WHAT PERCENTAGE OF WATER DOES HAY LOSE DURING STORAGE?

Result of Rhode Island Official Experiment.

Hay which had been stored during the summer of 1901, was removed from the mow the following February, and found to contain 12.21 per cent. of water. A careful comparison of other moisture determinations of hay leads to the conclusion that 12.21 is a fair general average of the percentage of water in the best quality of barn-cured hay. When hay is first stored it usually contains from 20 to 28 per cent. of moisture. The loss in storage may be said to be about twelve to sixteen per cent.

GRADES OF HAY AND STRAW.

Adopted by the National Hay Association.

HAY.

No. 1 Timothy Hay: Shall be timothy with not more than one-eighth (1/8) mixed with clover or other tame grasses properly cured, good color, sound and well baled.

Standard Timothy: Shall be timothy with not more than one-eighth (1/8) mixed with clover or other tame grasses, fair color, containing brown blades, and brown heads, sound and well baled.

No. 2 Timothy Hay: Shall be timothy not good enough for No. 1 not over one-fourth (1/4) mixed with clover or other tame grasses, fair color, sound and well baled.

No. 3 Timothy Hay: Shall include all hay not good enough for other grades, sound and well baled.

Light Clover Mixed Hay: Shall be timothy mixed with clover. The clover mixture not over one-third (1/3) properly cured, sound, good color and well baled.

No. 1 Clover Mixed Hay: Shall be timothy and clover mixed, with at least one-half (1/2) timothy, good color, sound and well baled.

Heavy Clover Mixed Hay: Shall be timothy and clover mixed with at least one-fourth (1/4) timothy, sound and well baled.

No. 2 Clover Mixed Hay: Shall be timothy and clover mixed with at least one-third (1/3) timothy. Reasonably sound and well baled.

No. 1 Clover Hay: Shall be medium clover not over one-twentieth (1/20) other grasses, properly cured, sound and well baled.

No. 2 Clover Hay: Shall be clover sound, well baled, not good enough for No. 1.

Sample Hay: Shall include all hay badly cured, stained, threshed or in any way unsound.

Choice Prairie Hay: Shall be upland hay of bright, natural color, well cured, sweet, sound, and may contain 3 per cent. weeds.

No. 1 Prairie Hay: Shall be upland and may contain one-quarter (1/4) midland, both of good color, well cured, sweet, sound, and may contain 8 per cent. weeds.

No. 2 Prairie Hay: Shall be upland, of fair color and may contain one-half midland, both of good color, well cured, sweet, sound, and may contain 12 1/2 per cent. weeds.

No. 3 Prairie Hay: Shall include hay not good enough for other grades and not caked.

No. 1 Midland Hay: Shall be midland hay of good color, well cured, sweet, sound, and may contain 3 per cent. weeds.

No. 2 Midland Hay: Shall be fair color or slough hay of good color, and may contain 12½ per cent. weeds.

Packing Hay: Shall include all wild hay not good enough for other grades and not caked.

Sample Prairie Hay: Shall include all hay not good enough for other grades.

STRAW.

No. 1 Straight Rye Straw: Shall be in large bales, clean, bright, long rye straw, pressed in bundles, sound and well baled.

No. 2 Straight Rye Straw: Shall be in large bales, long rye straw pressed in bundles, sound and well baled, not good enough for No. 1.

No. 1 Tangled Rye Straw: Shall be reasonably clean rye straw, good color, sound and well baled.

No. 2 Tangled Rye Straw: Shall be reasonably clean, may be some stained, but not good enough for No. 1.

No. 1 Wheat Straw: Shall be reasonably clean wheat straw, sound and well baled.

No. 2 Wheat Straw: Shall be reasonably clean; may be some stained, but not good enough for No. 1.

No. 1 Oat Straw: Shall be reasonably clean oat straw, sound and well baled.

No. 2 Oat Straw: Shall be reasonably clean; may be some stained, but not good enough for No. 1.

ALFALFA.

Choice Alfalfa: Shall be reasonably fine leafy alfalfa of bright green color, properly cured, sound, sweet, and well baled.

No. 1 Alfalfa: Shall be reasonably coarse alfalfa of a bright green color, or reasonably fine leafy alfalfa of a good color and may contain two per cent. of foreign grasses, 5 per cent. of air bleached hay on outside of bale allowed, but must be sound and well baled.

Standard Alfalfa: May be of green color, of coarse or medium texture, and may contain 5 per cent. foreign matter. Or it may be of green color, of coarse or medium texture, 20 per cent. bleached and 2 per cent. foreign matter. Or it may be of a greenish cast of fine stem and clinging foliage, and may contain 5 per cent. foreign matter. All to be sound, sweet, and well baled.

No. 2 Alfalfa: Shall be of any sound, sweet and well baled alfalfa, not good enough for standard, and may contain 10 per cent. foreign matter.

No. 3 Alfalfa: May contain 35 per cent. stack spotted hay, but must be dry and not to contain more than 8 per cent. of foreign matter. Or it may be of a green color and may contain 50 per cent. foreign matter. Or it may be set Alfalfa and may contain 5 per cent. foreign matter. All to be reasonably well baled.

No grade Alfalfa: Shall include all alfalfa not good enough for No. 3.

The Alfalfa, Cow Pea and Clover Question.

Use of Legumes.

This class of plants has the property of taking inert Nitrogen from the air and transforming it into combinations more or less useful as plant food. This feature is of great value to agriculture, but not so much from the plant food point of view as from the fact that these plants are rich in that kind of food substance commonly called "flesh formers." Liberally fertilized, and not omitting Nitrate in the fertilizer, we have a crop containing more Nitrogenous food (protein or flesh formers) than the Nitrogen actually given as fertilizer could have made by itself. The most common plants of this class are: alfalfa, alsike clover, crimson clover, red clover, Japan clover, cow peas, lupines, Canadian field peas, the vetches, etc. All these forage crops should be sown after clean culture crops. The best method of fertilizing is to apply from 300 to 500 pounds of fertilizer early every autumn; in the spring, top-dress with 200 pounds of Nitrate of Soda, and repeat with about 100 pounds after each cutting. It is true that clovers *may* supply their own nitrogenous plant food, but this is an experiment experienced farmers do not often repeat. A fair green crop of clover, for example, removes from the soil some 160 pounds of Nitrogen, while in 500 pounds of Nitrate of Soda there are less than 100 pounds. Undoubtedly, the Nitrogen taken from the air is a great aid, but we should not expect too much of it. The method of seeding clovers depends much upon locality and soil needs with reference to previous crops. Crimson clover and Canadian field peas are usually sown in August, after earlier crops have been removed, or even in corn fields. Red clover is commonly sown in the spring on wheat or with oats.

Wheat.

The soil for this grain, fall planting, ranges from a clay loam to a moderate sandy loam. For spring wheat, moist peaty soils are used. Wheat is usually grown in rotation, in which case it nearly always follows corn, or a clean culture crop. The nature of cultivation is too well known to require mention here. Both spring and winter wheat are commonly fertilized crops, particularly the latter. The average fertilizer for wheat should contain Nitrogen, phosphoric acid and potash. This fertilizer is applied with the seed, and at the rate of 500 pounds to the acre. Nitrate of Soda is also applied broadcast as a top-dressing, soon after the crop shows growth in the spring, at the rate of 100 pounds per acre. Like all grains, wheat should have its Nitrate plant food early, and in the highly available, easily digested Nitrated form, such as is only to be found commercially as Nitrate of Soda.

The plant food needs of a crop of 30 bushels of wheat per acre amounts to about 70 pounds of Nitrogen, 24 pounds of phosphoric acid, and 30 pounds of potash; this includes the straw, chaff and stubble. One hundred pounds of Nitrate of Soda supplies about 16 pounds of Nitrogen, so that the quantity mentioned for top-dressing is a minimum quantity. Much has been said of legume Nitrogen for wheat, the crop being generally grown in rotation. Whatever Nitrogen the clover may have gathered, a crop of timothy and a crop of corn must be supplied before the wheat rotation is reached. In many cases, simply top-dressing with the Nitrate will be found effectual. In all cases where the acre yields have fallen off, a top-dressing of Nitrate of Soda should be applied.

Professor Maercker states that Nitrate of Soda for wheat is absolutely necessary under the conditions in Germany, and that 100 pounds of Nitrate of Soda pro-

Wheat.

Wheat—14 Bushels.

Average product per acre for the U. S. of wheat with average farm fertilization—1910.

Wheat—37 Bushels.

The product of an acre of wheat fertilized with Nitrate of Soda, home mixed with phosphates and potash—1910.

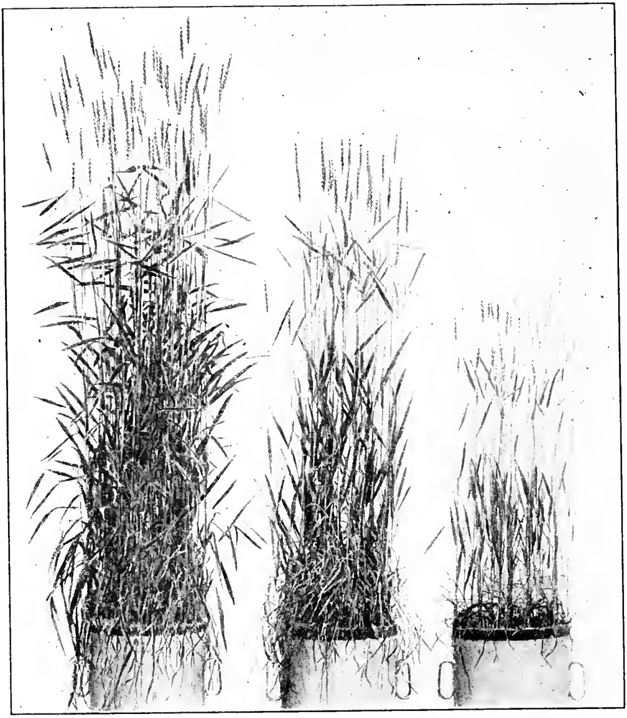
duces 300 to 400 pounds of grain and a corresponding amount of straw.

How to Apply Nitrate of Soda to Wheat.

Drill in with the wheat in the fall a mixture of 250 pounds of acid phosphate and 50 pounds Nitrate of Soda per acre. If your land is sandy, add 50 pounds of sulphate of potash to the above. Early in the spring, sow broadcast 100 pounds Nitrate of Soda per acre.

Land sown to wheat in the fall and seeded down with timothy and clover giving a heavy crop, followed by a heavy hay crop the following year, proved the beneficial after-effect of the Nitrate and that the Nitrate

Fertilizer Experiment with Wheat.



Phosphoric Acid and Potash with 1 oz. Nitrate of Soda. Yield: $3\frac{1}{5}$ oz. Grain.	Phosphoric Acid and Potash with $\frac{1}{4}$ oz. Nitrate of Soda. Yield: $1\frac{1}{2}$ oz. Grain.	Phosphoric Acid and Potash without Nitrate of Soda. Yield: $\frac{1}{2}$ oz. Grain.

had not leached away as so many critics claim, and further that the soil had not been exhausted.

Professor Massey writes in regard to the effect of Nitrate of Soda on Wheat, as follows:

I have made several experiments with Nitrate of Soda. The first was on wheat in Albemarle County, Virginia. I used 200 pounds per acre on part of the field which had been fertilized with 400 pounds acid phosphate in the fall. The result was 9 bushels per acre more than on the rest of the field, and a stand of clover, while none of any account stood on the rest of the field.

Wheat Experiments in England.

From 100 to 150 pounds of Nitrate of Soda per acre should be broadcasted on wheat, as soon as the new growth shows in the spring. The results of such treatment are shown by experiments made by three English gentlemen, which are tabulated as follows, mineral plant food being present in abundance:

I.	No Nitrate, 23 bu.	300 lbs. Nitrate, 33.5 bu.	Gain 46 p. ct.
II.	" 15 "	300 " " 28.0 "	" 87 "
III.	" 34 "	300 " " 49.0 "	" 44 "
			Average 59

Cotton-seed Meal Compared with Nitrate.

Another illustration is an experiment made by the late Dr. Voelcker; 672 pounds of cotton-seed meal were used in comparison with 275 pounds of Nitrate of Soda, with the result that the latter gave a return of 46.75 bushels per acre, a gain over the cotton-seed meal of nearly 24 per cent., the above enormous application of cotton-seed meal yielding but 37.7 bushels per acre.

Forty Bushels of Wheat to the Acre a Possible Average on Many Ohio Farms.

Bulletin 282, Ohio Experiment Station.

For twenty years the Ohio Experiment Station has grown potatoes, wheat and clover in a three-year rotation on one of its farms in Wayne county, a farm no better in natural fertility than thousands of others which may be found in this region of the State.

The land under experiment is divided into three sections and each crop is grown every season. Each section is sub-divided into plots of one-tenth acre each, every third plot being left continuously without fertilizer or manure, while the intervening plots have received different combinations of fertilizing materials, the fertilizers being divided between the potato and wheat crops.

The average yield of wheat in this test for the last ten years has been twenty-five bushels per acre on the unfertilized land. The application of 160 pounds of acid phosphate per acre to wheat, following a like application to potatoes, has increased the wheat yield by five bushels. When to this application, 100 pounds of muriate of potash was added for each crop, the yield of wheat was increased by seven bushels, while the use of a complete fertilizer, made up of 160 pounds of acid phosphate, 100 pounds of muriate of potash and the equivalent of 160 pounds of Nitrate of Soda for each crop, has increased the total yield of wheat to more than forty bushels per acre for the ten-year average.

The increase in the potato crop in each of these cases has more than paid for the fertilizer, leaving the increase in wheat as net gain, a gain which has been further augmented by a considerable increase in the yield of clover.

Not only has the yield been maintained at a high point, but it seems to be steadily increasing; the average yield for the three plots which receive the combination given, and which are located in different parts of the field, being 38¼ bushels per acre for the first half of the ten-year period, and 42½ bushels per acre for the second half.

It has therefore been possible to produce forty bushels of wheat per acre in Ohio as a ten-year average, and to accomplish this result by a method which has much more than paid the cost.

It is the general observation of farmers, that wheat does exceptionally well when it follows potatoes, and this fact in part accounts for the large yields obtained in this experiment. The fact that the land was in good condition to start with—part of it having been cleared from the forest for purposes of this test, must also be borne in mind. But on another of the Station's Wayne county farms, one which had been reduced to a very low state of fertility by long continued and exhaustive cropping, an average yield of 28½ bushels of wheat per acre has been maintained for the same period in a rotation of corn, oats, wheat, clover and timothy.

In this test the unfertilized yield has been 9½ bushels of wheat per acre. This yield has been increased

Fertilizer Experiments with Oats on Clay Soil.

Full Nitrate of Soda Fertilizing. Yield: 3 oz. grain.	Without Phosphoric Acid. Yield: ¾ oz. grain.	Without Potash. Yield: 2 oz. grain.	Yield: ⅕ oz. grain Without Nitrate of Soda.

to 28½ bushels by a fertilizer of the same composition as that above mentioned, namely: 160 pounds acid phosphate, 100 pounds of muriate of potash and the equivalent of 160 pounds of Nitrate of Soda per acre.

In this case, as in the potato rotation, the increase in the other crops of the rotation has more than paid all the cost of the fertilizers, leaving the increase of wheat as clear gain.

In this case also the rate of gain is increasing, the average yield for the first five years of the period being 25 bushels per acre, as against 32 bushels for the last five years, and there seems to be no good reason to doubt that after the wasted fertility of this land has been restored it will be possible to still further increase the

Rye.

Rye—18 Bushels.

Average product per acre for the U. S. of rye with average farm fertilization.

Rye—36 Bushels.

The product of an acre of rye fertilized with Nitrate of Soda, home mixed with phosphates and potash.

yield to a point equaling that in the experiment first mentioned.

Wheat and Oats, Rye and Barley.

(Bulletin 44, Georgia Agricultural Experiment Station.)

This bulletin gives in detail the results of experiments on wheat with fertilizers, in which Nitrate of

Soda is compared with cotton-seed meal; in all cases the plots were liberally supplied with phosphoric acid and potash. The average yield of four plots in each instance amounted per acre to 49.4 bushels for Nitrate of Soda, and 40.1 bushels for cotton-seed meal, a gain for Nitrate of Soda of over 23 per cent. A similar experiment with oats gave a return of 60 bushels for Nitrate of Soda and only 42 bushels for cotton-seed meal, a gain for Nitrate over cotton-seed meal of nearly 43 per cent. The Bulletin recommends, even when cotton-seed meal is used in the complete fertilizer, to employ Nitrate of Soda as a top-dressing in the spring.

Nitrate and Cotton-seed Meal Compared on Wheat.

Three hundred pounds per acre more Wheat, Oats, Rye or Barley may be raised by the use of 100 pounds of Nitrate of Soda used as a top-dressing on the soil. Frequent trials at Agricultural Experiment Stations the world over fully prove this to be so.

MARYLAND AGRICULTURAL EXPERIMENT STATION.

Bulletin No. 91.

Page 44. Table 7.

Nitrate of Soda vs. No Nitrate of Soda Applied on Wheat; Wheat Unfertilized in Fall.

Plot No.		Yield of Grain per Acre, Bushels.
1.	Neither fertilizer nor Nitrate of Soda......	10.4
2.	Nitrate of Soda, with no Other Fertilizer...	18.1*

Comparison of Nitrate of Soda and Sulphate of Ammonia Both With and Without Lime.

As has already been explained, Nitrate of Soda and Sulphate of Ammonia represent the mineral sources of Nitrogen commonly found on the market. The

* Gain of 7.8 bushels, or 75 per cent.

Nitrate of Soda is readily soluble in water and is directly available to plants; while the Sulphate of Ammonia, though quite soluble, has to be changed into Nitrate before it can be used by crops. Hence the action of these two materials is not the same on different soils and under varying weather conditions. The sulphate has been preferred by some because it would act slower; yet if conditions for nitration were unfavorable, it might not be available to the crop when needed. Again, under some circumstances, Sulphate of Ammonia has been found to be actually harmful* to plants.

SOUTH CAROLINA AGRICULTURAL EXPERIMENT STATION.

From Bulletin No. 56, p. 5.

Wheat.

I.	*Comparison of Varieties.*	*IV.*	*Home Manures.*
II.	*Quantity of Seed per Acre.*	*V.*	*Commercial Fertilizers.*
III.	*Experiment with Nitrogen.*	*VI.*	*Tillage.*

Fertilizers. If wheat is sown upon land deficient in organic matter, it is wise to use a complete fertilizer, containing Nitrogen, phosphoric acid and potash.

If wheat shows an unhealthy appearance in early spring, especially upon sandy lands, an application of seventy-five pounds of Nitrate of Soda will prove beneficial provided there is enough phosphoric acid in the soil to co-operate with it and make the grain.

Experiment with Nitrogen.

Object. To compare effects of Nitrogen from cotton-seed meal and Nitrate of Soda and the latter applied with the seed and as a top-dressing.

The intention was to use on each plot a constant quantity of phosphoric acid and potash as the equiv-

* On account of its leaving a strong mineral acid residue in the soil, after its Nitrogen has been nitrated by the soil.

alent of these ingredients in 200 pounds of cotton-seed meal.

The first plot received cotton-seed meal alone —yield	17.5 bus.
The second, phosphoric acid and potash and Nitrate of Soda all applied with the seed —yield	20.8 bus.
The third received only phosphoric acid and potash—yield	17.6 bus.
The fourth received in addition to phosphoric acid and potash applied with the seed, Nitrate of Soda as a top-dressing—yield	19.4 bus.

Barley.

This crop does best on a strong clay loam, but the soil must not be rich in organic matter. Soils naturally rich in ammoniates are unfavorable, as one of the most important points in high-grade barley is a complete maturity of the grain. With soils rich in vegetable matter, the supply of the only digestible Nitrogen or what is exactly the same thing, Nitrates, continues so late in the season that maturity is retarded seriously. About 400 pounds per acre of fertilizer should be applied broadcast before seeding. As soon as the grain is "up," top-dress with 150 pounds of Nitrate of Soda per acre. If the soil is very rich, apply only 100 pounds of Nitrate.

Barley and Oats.

We would recommend drilling in with the Barley or Oats a mixture of 250 pounds acid phosphate and 100 pounds Nitrate of Soda per acre, and if the land is very sandy add 100 pounds sulphate of potash to the mixture.

In an experiment at Woburn, made for the Royal Agricultural Society of England, by the late Dr. Voelcker, the following results were obtained:

Mineral manures and sulphate ammonia	36.75 bushels per acre.
Nitrate 275 lbs. and minerals	42.50 bushels per acre.

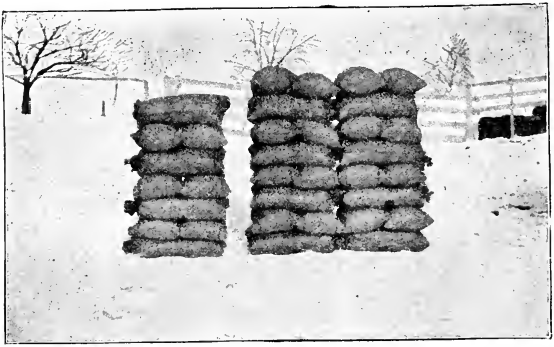
Gain for Nitrate, 16 per cent.

The ammonia salt and the Nitrate used contained the same amount of nitrogen plant food. Compared with cotton-seed meal, 124 pounds of Nitrate of Soda gave 49.5 bushels barley per acre as compared to 37 bushels from 1,000 pounds cotton-seed meal applied the previous year. Gain for Nitrate 33.7 per acre.

Oats.

This grain does well on nearly all types of soil, but responds freely to good treatment. There is a vast difference in the quality of oats when grown on poor or rich soils. Perhaps no other crop so effectually conceals impoverishment; at the same time the feeding value of oats grown on poor soil is very low. In the North oats

Oats.



30 Bushels.

Average product per acre, for the U. S. of oats, with average farm fertilization.

65 Bushels.

The product of an acre of oats fertilized with Nitrate of Soda.

are sown in the spring, and usually after corn or a turned down clover sod. In such cases the crop is rarely ever given fertilizer, but shows an excellent return for a top-dressing of 100 pounds of Nitrate of Soda per acre. The crop has strong foraging powers, and will find available mineral plant food where a wheat crop would utterly fail. On soils pretty badly exhausted, an application of 400 pounds of fertilizer will yield a profitable return, provided the top-dressing of Nitrate is not omitted. Under any condition of soil or fertilizing, a sickly green color of the young crop shows need of Nitrate of Soda plant food, and the remedy is a top-dressing of Nitrate. In seeding, use two or three bushels to the acre.

In many places in Europe the cereals, like oats and wheat, are planted or sown in rows and cultivated as we cultivate Indian corn. It is claimed that this increases yield materially, and is of great aid in helping to avoid lodging. It requires less seed per acre and increases the yield.

Another method in vogue is to sow less seed per acre broadcast and use more fertilizer, so that the individual stalks are stronger and bigger.

Autumn dressings of Nitrate are used frequently in Europe, and in connection with minerals as much as three hundred (300) pounds of Nitrate per acre is used annually.

NITRATE TEST.

At Kentucky Experiment Station.

BULLETIN 99.

The oats in this experiment were sown in April and harvested in July. Plot No. 1 was one acre in area; the others were one-half acre each.

No fertilizer, yield,	27.5 bushels.
160 lbs. Nitrate of Soda, yield,	37.1 bushels.

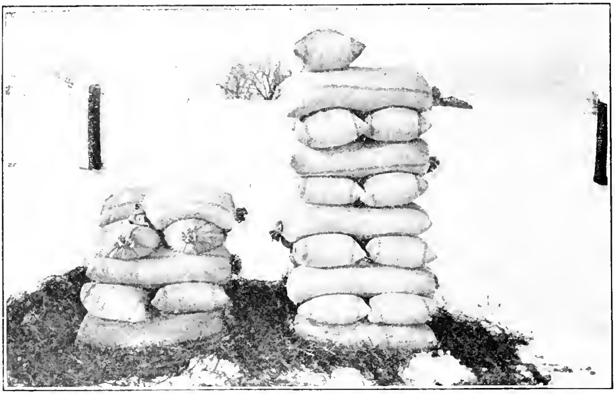
An authenticated experiment made by Mr. P. Dickson, of Barnhill, Laurencekirk, N. B., gave a return from the use of 112 pounds of Nitrate of Soda of 64 bushels per acre, while the soil without Nitrate gave a crop of only 36 bushels. Top-dressings for oats should average 100 pounds to the acre.

It should always be applied some ten days after the young plants have broken ground.

Rye.

This is another illustration of the necessity of care in the use of fertilizer Nitrogen. Rye does best on lighter soils so long as they are not too sandy, but if the soil is rich in vegetable matter, or if a fertilizer is used containing much organic ammoniate, the grain yield will be disappointing; the crop fails to mature in season because the Nitration of organic Nitrogen or humus is greatest during the warm days of mid-summer, and a constant supply of available Nitrate is being furnished at a time when the crop should commence to mature. The crop needs Nitrate, but it should have been supplied during the earlier stages of growth. Use at first a general fertilizer, 500 pounds per acre. Top Dress as soon as the crop shows growth in the spring with 100 pounds of Nitrate of Soda to the acre, broadcast.

Buckwheat.



No Nitrate.
Yield, 19 bushels per acre.

Fertilized with 125 lbs. Nitrate of Soda per acre.
Yield, 38 bushels per acre.

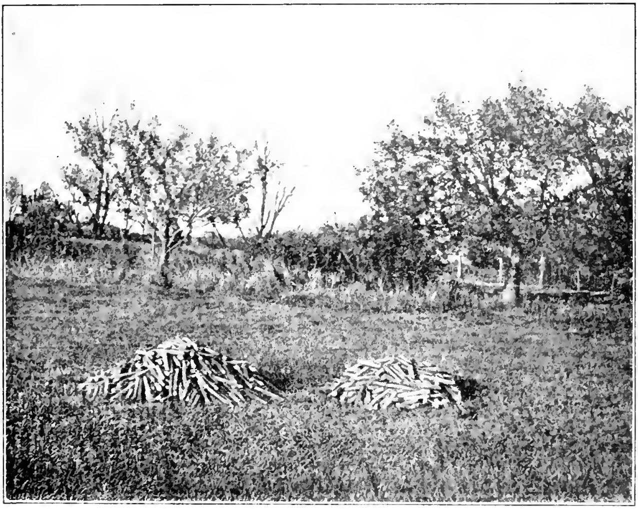
Buckwheat.

This crop does well on almost all kinds of soil, but should follow a grain or hoed crop—that is, a clean cultivation crop. On thin soils use about 400 pounds of general fertilizer to the acre, applied just before seeding, or even with the seed. Heavy soils do not require fertilizing for this crop, as it has exceptional foraging powers, and will find nourishment where many grain crops would starve. As soon as the plants are well above ground, apply a top-dressing of 100 pounds of Nitrate of Soda per acre, both on strong and light soils. Use one bushel of seed per acre on thin soils, but a heavier application on richer soils.

Corn.

This crop is specially adapted for making use of roughage of all sorts. It has a long season of growth

Corn.



Fertilizer, 300 pounds per acre minerals and 150 pounds per acre Nitrate of Soda. Rate of yield, 100 bushels ears per acre, excellent quality.

Fertilizer, 300 pounds per acre minerals only. Rate of yield, 80 bushels ears per acre, poor quality.

and makes its heaviest demand for food late in the season when the conditions are such that soil Nitration is at its highest period of development. It is also a deep rooting crop and capable of drawing its food and water from great depths. It needs vast quantities of water, and the tillage must be very thorough that an even earth mulch may be practically continuous. In the early spring it frequently starts off slowly, and on this account should have some help in the form of hill applications of highly available plant food.

Sweet corn is quite a different crop from field corn; it has a much shorter period of growth and should be fertilized much more heavily. The object in this case is not a matured grain, and Nitrate of Soda should be used very liberally in the shape of top-dressings.

Hops.

A Record of Four Years' Experiments with Hops.

The experiments were conducted at Golden Green, Hadlow, near Tunbridge, England, and under the supervision of Dr. Bernard Dyer. Seven plots were arranged, all except No. 7 receiving equal and ample quantities of phosphoric acid and potash, but varying amounts of Nitrate of Soda, and (plot 7) thirty loads of stable manure. The fertilizing of the plots, and the average crop, kiln dried hops per acre, with the percentage of gain over the plot not treated with Nitrate, are shown in the following table.

	Plot and Fertilizer.	Kiln dried Hops.	Gain Per Cent.
1	No Nitrate	9.75 cwt.	—
2	2 cwt. Nitrate	12.00 "	23
3	4 " "	13.67 "	39
4	6 " "	13.75 "	41
5	8 " "	14.58 "	49
6	10 " "	14.58 "	49
7	30 loads manure	10.25 "	5

The results show a material gain in the crop from the use of Nitrate of Soda, but the applications on plots 5 and 6 are perhaps greater than will prove economical. The quality of the crop was given exhaustive examination, with the results that plots 2, 3, 4 and 7 graded all the same, and the highest. The quality on the other plots was not materially different. As a result of the investigation, Dr. Dyer recommends Nitrate of Soda strongly for hop growing, but suggests early applications.

Market Gardening with Nitrate.

Results in an Unfavorable Growing Season with Low Prices for Products.

The following is the result of a practical study of conditions on a large truck farm, near New York. In every case the operations of the farm were carried out on a strictly business basis. The soil was a heavy clay with a rather intractable clay subsoil, decidedly not a soil naturally suited to growing garden crops. The weather was unfavorable, including the most severe drought in thirty years; from March 22d to July 8th practically no rain fell. Owing to the unfavorable season, the grade of garden products was low, causing a low ruling in prices. Details by crops follow:

Asparagus.

The bed was twenty years old, and had been neglected. As soon as workable, it was disc-harrowed, and later smooth-harrowed with an Acme harrow. Nitrate of Soda was applied to the best test plots April 10th, 200 pounds per acre, sown directly over the rows and well worked into the soil. A second application of 100 pounds per acre was made to plot 1 April 24th; and, on the 29th, a third application of equal amount.

The experiment comprised three plots, two fertilized with Nitrate of Soda, and one without Nitrate, plot 3. Plots 1 and 2, treated with the Nitrate, produced marketable stalks ten days in advance of plot 3, a very material advantage in obtaining the high prices of an early market. The results were as follows, in bunches per acre:

Plot and Fertilizer.		Bunches per acre.	Gain.
3	No Nitrate	560	——
2	200 lbs. Nitrate	680	120
1	400 lbs. Nitrate	840	280

The financial results were as follows, prices being those actually obtained in the New York markets:

	Plot 1.	Plot 2.	Plot 3.
Fertilizer, Nitrate...........	400 lbs.	200 lbs.	——
Gross receipts..........	$207.90	$161.50	——
Fertilizer cost..........	8.40	4.20	——
Applying fertilizer......	2.00	1.00	——
Net receipts............	197.50	161.50	$112.00
Nitrate made gain......	85.50	44.30	——

The use of 400 pounds of Nitrate of Soda produced on plot 1 a gain of $85.50 on a fertilizer and application cost of $10.40; the use of 200 pounds of Nitrate returned a similar gain of $44.30 on a fertilizer and application cost of $5.20.

Snap Beans.

The beans were grown for pods, or what is known as string beans. Three varieties were experimented with, Challenger, Black Wax, and the Red Valentine. Seeds were drilled in May 10th, in rows two feet apart; on May 22nd, an application of 100 pounds of Nitrate of Soda per acre was made, and on the 27th, another application of 150 pounds was drilled. June 12th, an application of 50 pounds was drilled along the rows, followed by 100 pounds June 19th; in all 400 pounds of Nitrate of Soda per acre. Half the field was not treated with Nitrate. In case of the Black Wax beans, the Nitrated land gave a crop 6 days in advance of the part not treated with Nitrate, and the same gain was made by the Nitrated Valentine beans. The Black Wax beans treated with Nitrate produced 75 per cent. more marketable crop than the non-Nitrated portion, and the Valentine variety 60 per cent. Taking into consideration the enhanced price due to earlier ripening, the average price of the Nitrated Black Wax beans averaged some 60 per cent. higher than the portion of the field not treated with Nitrate of Soda; in like manner, the increased price of the Valentine beans was 45 per cent.

Increase in Crop and Better Quality Resulted as well as Saving in Time.

Beets.

The crop must be forced to quick growth in order to obtain tender, crisp vegetables, quickly salable and at good prices. Nitrate of Soda was compared with unfertilized soil, with the result that on the Nitrated plots marketable beets were pulled 56 days from seeding; the unfertilized plot required 72 days to produce marketable vegetables. Nitrate of Soda was applied at the rate of 500 pounds per acre, in four applications.

Table Beets Grown on Nitrate were Ready for Market 16 Days Ahead of Unfertilized Plots.

Early Cabbage.

The cabbage plots were thoroughly worked up, and planted to Henderson's Early Spring Variety. Part of the soil was treated with Nitrate of Soda at the rate of 575 pounds per acre, in five applications ranging from May 1st to June 17th. The part of the plot not treated with Nitrate of Soda was a total failure, but allowing the same number of plants as the fertilized portion, and also allowing for difference in price on account of later ripening, the crop on the portion not treated with Nitrate should have returned a gross amount of $292.50. The Nitrated portion returned gross receipts of $720, from which deducting $19.50 for fertilizer and application of same, we have $700.50 for Nitrate of Soda as compared with $292.50 without Nitrate, a net profit for the Nitrate of $408. That is, for every dollar spent for Nitrate of Soda, the crop returned an additional $21 nearly.

How a Crop was Saved from Total Failure.

A Dollar Spent in Nitrate Returned $21.00 in Increased Crop.

Celery.

Crisp stalks of rich nutty flavor are a matter of rapid, unchecked growth, and plant food must be present in unstinted quantity, as well as in the most quickly available form, the best example of which is

Nitrate of Soda. The soil was plowed early in May, and subsoiled, thoroughly breaking the soil to a depth of 10 inches. Thirty bushels of slaked lime were broadcasted per acre immediately after plowing, followed by a dressing of 20 tons of stable manure, all well worked into the soil. Plants were set May 10th.

Extraordinary Returns on Celery.

The tract was portioned into three tracts for experimental purposes; plot 1 received 675 pounds of Nitrate of Soda per acre in six applications, May 16th, 22nd, June 1st, 10th, 17th and 24th. Plot 2 received 475 pounds in five applications, May 16th, 22nd, June 1st, 17th and 24th. Plot 3 was not treated with Nitrate of Soda.

Plot 1 was ready for market July 6th, and was all off by the 10th. Plot 2 was ready for market July 11th and was all harvested by the 14th. Plot 3 was practically a failure and was not harvested. Plot 1, being first in the market, had the advantage of the best prices; the gross receipts were, per acre, $957.80; from which must be deducted $18.67 for Nitrate of Soda and the application of same—a net result of $939.13 per acre. Plot 2 gave a gross return of $676.30, from which $13.72 must be deducted for fertilizer, leaving $662.58 per acre net. Plot 1 makes therefore a gain of $276.55 over plot 2, simply from the earliness in maturing, due to the heavy applications of Nitrate, for the total crop was approximately the same for both plots.

Cucumbers.

Plants were set in box frames May 4th. The frames were well filled with rotted manure, and were banked as a protection against late frosts. A portion of the field was treated with Nitrate of Soda; on May 10th each plant was given a quart of a solution made by dissolving three pounds of Nitrate of Soda in 50 gallons of water. Applications in quantity the same were made on the experimental plot May 16th, 22nd, 29th, June 3rd, 9th, 15th, 22nd and 26th; making a total of 165 pounds of Nitrate of Soda per acre. On June 27th the experimental plot was setting fruit rapidly, while the plot not Nitrated was just coming into bloom. The Nitrated plot was given on June 29th a quart of a solution made by dissolving two ounces of Nitrate of Soda in a gallon of water; and this application was repeated July 3rd, 7th, 15th, 24th and August 8th. This practically doubled the Nitrate application.

Gain in Time in this Crop Very Remarkable, Two Weeks in Advance.

The first picking on the Nitrated plot was made July 1st, on the non-Nitrated plot July 22nd, when prices were at the lowest point. After the early market season was over, the vines were treated for pickling cucumbers, the Nitrated plot receiving 50 pounds of Nitrate of Soda dissolved in water as before; later, two applications of a quart each, containing half an ounce per gallon. The result was that the vines continued bearing until cut down by frost. The estimated yields were as follows: Nitrated plot, per acre, 6,739 dozen, plot not Nitrated gave per acre 948 dozen.

Sweet Corn.

The crop was planted on rather poor soil. Seed was planted May 4th, and the cultivators started May 12th. A portion of the field was selected for experiment, and on this an application of 75 pounds of Nitrate of Soda per acre was made May 20th, drilled close to the row. A second application of the same amount was made May 20th, and on June 5th a third application. On June 17th there were 100 pounds per acre applied and cultivated into the soil. The total Nitrate applied to the experimental plot amounted to 325 pounds per acre. The Nitrated plot ripened corn 5 days ahead of the non-Nitrated portion, and produced 994 dozen ears against 623 dozen from an acre not treated with Nitrate of Soda. The Nitrated crop, being earlier in the market, brought better prices; the gross return being $99.40 per acre as compared with $62.30 for the non-Nitrated plot. The cost of the Nitrate and its application expenses amounted to $9.75 per acre, leaving a net gain from the use of Nitrate of Soda, of $27.35 per acre.

Egg-Plant.

The plants were set in the usual manner, part of the tract being treated with Nitrate of Soda at the rate of 475 pounds per acre to observe the practical value of the Nitrate for forcing. Before setting, the plants were given a light application of Nitrate in solution. June 1st, 150 pounds was the amount used, on the 10th this was repeated, and on June 22nd, a third application was made. The Nitrated plot produced marketable fruit July 5th, the non-Nitrated plot did not reach the market until July 26th. The Nitrated plot produced per acre 33,894 fruits, all of good quality; the non-Nitrated plot produced only 8,712 fruits per acre.

Kale.

An application of 50 pounds of Nitrate of Soda and 100 pounds of Dried Fish per acre, in May, increased the growth 30 per cent.

Early Lettuce.

The plants were started in the hot-house, and pricked into cold frames; April 26th they were set in the field. The Nitrate applications on the experiment plot were per acre as follows: April 29th, 100 pounds; May 4th, 150 pounds; May 12th, 200 pounds; May 18th, 200 pounds; May 23rd, 100 pounds; a total of 750 pounds per acre. The Nitrated plot was first cut May 26th, and at this time the non-Nitrated plot was just beginning to curl a few leaves towards the heart for heading. Approximately, the Nitrated plot produced per acre 1,724 dozen heads, and were ready for market so early that the average wholesale price was 25 cents per dozen; per acre, $431.00. From this we must deduct $20.00 for Nitrate and the expense of applying same, leaving net, $411.00. On the non-Nitrated plot only about 4 per cent. of the plants headed, and these reached the market three weeks late. The financial statement shows 48 dozen heads at 10 cents, or a net return per acre of $4.80. That is, without the Nitrate dressing, the crop was a failure.

Onions.

The soil was in bad condition, and was liberally limed. Seeding was completed April 15th, and the plants were rapidly breaking ground by the 28th. The tract was divided into three plots; plot 1 received 675 pounds of Nitrate of Soda in six applications at intervals of a week or 10 days; plot 2, 375 pounds in four applications; plot 3 was not treated with Nitrate. The Nitrated plots seemed least affected by the exceptionally dry weather, but the crop on all the plots was no doubt reduced by the unfavorable conditions. The following table gives the results by plots, computed to an acre basis:

	Nitrate 675 lbs.	Nitrate 375 lbs.	No Nitrate.
Total yield	756 bu.	482 bu.	127 bu.
Per cent. scullions	1.5	1.7	19.0
Average price per bushel	75 cts.	65 cts.	35 cts.
Total receipts	$567.00	$313.30	$44.50
Fertilizer cost	20.17	9.30	———
Total net receipts	546.83	304.00	44.50

The result shows very clearly that but for the Nitrate applications, the crop must have been a failure in every respect.

Early Peas.

This crop was planted under the same conditions and in like manner to the snap beans; an application of 300 pounds of Nitrate of Soda per acre was given, to the experiment plots. Two varieties were planted, early and late. The results were:

	Early.		Late.	
	Nitrate.	Nothing.	Nitrate.	Nothing.
Date planted	April 15	April 15	May 1	May 1
First picking	June 8	June 17	June 29	July 4
Gain to Market	9 days	———	5 days	———
Period of bearing	11 days	8 days	10 days	6 days
Crop on first picking	55 p. ct.	40 p. ct.	57 p. ct.	38 p. ct.
Total yield	165 p. ct.	100 p. ct.	168 p. ct.	100 p. ct.

The season was very unfavorable for this crop, yet the results show that the Nitrate made a powerful effort to offset this disadvantage. The earliness to market in this case is as pronounced as in the other garden crops, and is one of the most profitable factors in the use of Nitrate of Soda. The lengthening of the bearing period is an added advantage.

Early Potatoes.

Ploughing was finished the second week in April, and limed at the rate of 35 bushels per acre. Furrows were opened three feet apart, and 750 pounds per acre of a high-grade fertilizer worked into the rows. May 1st the potatoes were breaking ground, and an application of 100 pounds of Nitrate of Soda per acre on the experiment plot was made, followed on the 11th by 200 pounds of Nitrate, and on the 29th, 150 pounds more were cultivated in with a horse-hoe. The total Nitrate application per acre was 450 pounds. The Nitrated plot was harvested July 6th, and retailed at an average price of $1.60 per bushel; the plot not treated with Nitrate was dug July 17th, eleven days later, and the highest price obtained was 80 cents per bushel. The Nitrated plot produced per acre 19 bushels unmarketable tubers, the non-Nitrated plot 46 bushels. The total crop marketable was 297 bushels for Nitrate, and 92 bushels for non-Nitrated plot. Deducting the cost of Nitrate of Soda and the expense of applying same, the Nitrated crop was worth $463.30 per acre, while the non-Nitrated plot returned only $69.00 per acre. For every dollar expended for Nitrate of Soda, the crop increase gave $30.18 return.

Late Potatoes.

Conditions were the same as in the case of early potatoes, except the Nitrate of Soda was used at the rate of 500 pounds per acre, in five applications. The crop of marketable tubers on the Nitrated plot amounted to *374 bushels* per acre; on the non-Nitrated plot the yield amounted to *231 bushels* marketable tubers. The gain for Nitrate of Soda was 143 bushels, or nearly 62 per cent. increase.

Early Tomatoes.

With this crop the object is to mature quickly rather than to obtain a heavy acre yield; one basket of early tomatoes at $1.25 is worth more than 15 baskets later in the season, when the price is about 8 cents per basket. The plants to be used on the Nitrated plot were treated with a diluted solution of Nitrate four separate times. Plants were field set May 17th, and given six applications of Nitrate of Soda: 1st, 100 pounds per acre soon after setting out; 2nd, 3rd and 4th of 75 pounds each; and 5th and 6th of 50 pounds each—in all, about 425 pounds per acre. The results were:

	Nitrate.	No Nitrate.
Plants set out in field	May 17	May 17
First picking	June 30	July 19
Days, setting to first picking	43	62
Crop at $1.00 and upward per basket	40 p. ct.	———
" .75 " "	30 "	10 p. ct.
" .50 " "	20 "	15 "
" .30 " "	10 "	20 "
" .25 " "	———	25 "
" .15 " "	———	15 "
" .08 " "	———	15 "
Estimated yield per acre, baskets	500	600
Gross receipts	$377.50	$190.20
Cost of fertilizer and application	10.35	———
Net receipts	367.15	190.20
Gain per acre for Nitrate	176.95	———

The indicated gain amounts to a return of $17.09 for every dollar expended for Nitrate of Soda.

The experiments detailed in this pamphlet are all on a working basis. In every case the object was to force the crop to an early yield, and while the applications of Nitrate of Soda seem large and are large in proportion to the actual needs of the crops grown, at the same time the nature of market-gardening requires free use of immediately available plant food, and the results show that such use is very profitable.

Asparagus.

The soil should be sandy, or a light loam. As the crop remains in position for many years, the land should be selected with that fact in mind. The soil must be kept very clean and mellow. Stable manure is very objectionable on account of its weed seeds. It is only by a quick, even growth that large, crisp stalks can be produced, and there must be no check through a scanty supply of plant food. In the spring, as soon as the ground can be worked, clear off the rows and loosen up the soil, and apply broadcast along the rows a top-dressing of Nitrate of Soda, from 200 to 300 pounds. With this crop, the full application of Nitrate can be made at one time.

Enormous profits may be derived from the proper use of fertilizers on asparagus.

If the rent, labor, etc., for a crop of asparagus is $200 per acre, and the crop is three tons of green shoots at $100 per ton, on the farm, the profit is $100 per acre. If we get six tons at $100 per ton, the profit, less the extra cost of labor and fertilizer, is $400 per acre.

In such crops as asparagus, however, doubling the yield by the use of Nitrate of Soda does not tell half the story.

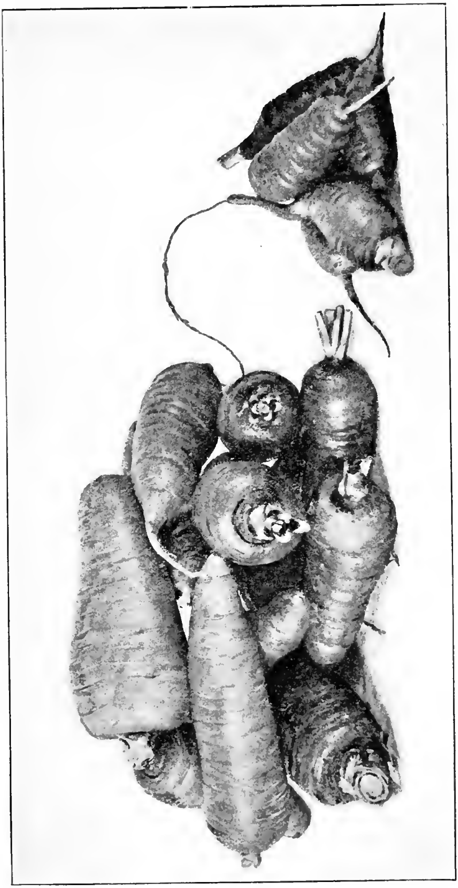
Asparagus is sold by the bunch, weighing about 2½ pounds. The prices range, according to earliness and quality, from 10 cents to 25 cents per bunch at wholesale, or from $80 to $200 per ton.

By leaving out all these considerations and assuming that the non-Nitrated asparagus yields three tons per acre and sells for $100 per ton, and that the Nitrated asparagus yields six tons per acre and sells for $200 per ton, the profits of the two crops, less the extra cost for labor and fertilizer, are as follows:

Without Nitrate of Soda..............	$ 100 per acre.
With Nitrate of Soda..................	1,000 per acre.

Beets, Carrots, Parsnips, Etc.

Market Garden Crops. For garden crops such as beets, carrots, parsnips, onions, spinach, lettuce, etc., sow the mixture as recommended for potatoes, broadcast before the seed is sown, at the rate of from 500 to 1,000 pounds per acre, according to the richness of the land. When the land has been heavily



Late Carrots.

No Nitrate.

300 lbs. of Nitrate of Soda to the acre, in two applications.

manured for a number of years, it may not be necessary to use so much phosphate and potash. Nitrate of Soda alone on such land often has a wonderful effect.

The best fertilizer is a mixture of 200 pounds of Nitrate of Soda and 350 pounds phosphate. A small quantity of sulphate of potash should be added when the land is sandy.

Cabbage and Cauliflower.

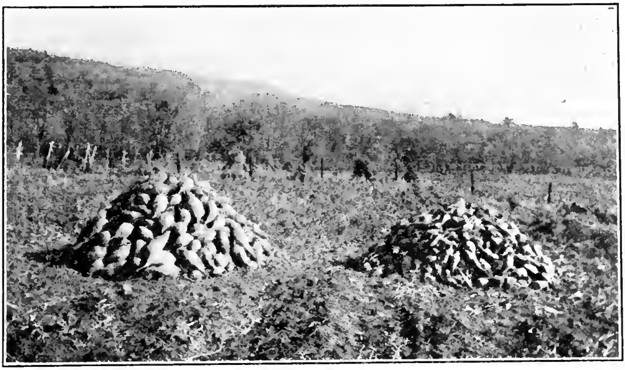
For growing cabbages and cauliflower sow broadcast the same mixture as recommended for potatoes, using a small handful to each square yard of ground, and rake or harrow it in before sowing the seed.

Cabbage requires a deep, mellow soil, and rich in plant food. Early maturing cabbage, perhaps the most profitable method of growing this vegetable, produces 30,000 pounds of vegetable substance to the acre, using about 140 pounds of ammonia, 129 pounds of potash, and 33 pounds of phosphoric acid, all as actually assimilated plant food. The crop must be fertilized heavily. As the soil is thoroughly fined in the spring, there should be incorporated with it by rows, corresponding to the rows of plants, about 1,500 pounds of fertilizer per acre. For early cabbage set close together: it will pay to sow the fertilizers broadcast over the whole ground and work them in before setting out the plants. If the land has been heavily manured for a number of years Nitrate of Soda alone may do as much good as the mixture. In this case, the Nitrate may be used after the plants are set out—a teaspoonful to a plant.

For late cabbage, set 2½ to 3 feet apart each way. It is a good plan to apply the fertilizers after the plants are set out.

After the plants have set and have rooted, say a week from setting, apply along the rows a top-dressing of 200 pounds of Nitrate of Soda per acre and work into the soil with a fine toothed horse hoe; the soil must be kept loose to a depth of at least two inches, and consequently there will be no extra labor in working this fertilizer into the soil. Some three weeks later incorporate in the same manner into the soil 300 to 400 pounds of Nitrate of Soda. Soil Nitration cannot be depended on under any circumstances for supplying enough natural Nitrate for cabbage. Nitrate of Soda is the only immediately predigested Nitrated ammoniate in the market and is an absolute necessity for early cabbage, and should be used liberally. This crop should not follow itself more than twice, as by so doing there is no little danger of serious disease to the crop.

Sugar Mangels.



300 lbs. Acid Phosphate.
100 lbs. Sulphate of Potash.
150 lbs. Nitrate of Soda.
Yield, 38,240 lbs. sugar mangels per acre.

300 lbs. Acid Phosphate.
100 lbs. Sulphate of Potash.
Yield, 24,120 lbs. sugar mangels per acre.

Cantaloupes.

A continuous and rapid growth in cantaloupes is essential to earliness and a good crop, and Nitrate of Soda under the proper conditions, and with proper care, yields just such results. A dressing of Nitrate of Soda alongside the rows in cultivating, in addition to the general fertilizer used, has been most successful.

Celery.

Phosphate should be worked into the land intended for growing celery plants, either the fall before or in the spring, before the seed is sown, at the rate of 500 pounds per acre. As soon as the plants come up, sow broadcast 500 pounds of Nitrate of Soda per acre, or a small handful to each square yard. If heavy rains occur, it is well to give the plants another application of Nitrate. This need not be as heavy as the first application.

Flowers.

Every gardener (of vegetables or flowers) should have at hand, all through the season, a bag or box of Nitrate of Soda, to be used as a top-dressing on any

Fertilizer Experiments with Fuchsias.

Phosphoric Acid and Potash without Nitrate of Soda. | Phosphoric Acid and Potash with $2\frac{1}{4}$ oz. Nitrate of Soda.

and every crop that grows in the garden. The need for nitrogen is indicated by the pale green color of foliage and slow growth. It is quite easy to be too liberal in using Nitrate. From 50 to 100 pounds per acre is the range in the quantity to be applied at any one time to one acre. One pound of it would give about 30 heaping teaspoonfuls. So 1 to 1½ such spoonfuls to a square yard, or 3 feet along a row that is 3 feet wide, would be about 100 pounds per acre. The quantity, however, may be larger where the plants —such as cabbage—are half grown and in good condition to grow.

Nitrate of Soda is an ideal fertilizer for all kinds of flowering plants, especially roses. It is, as you

Fertilizer Experiments with Chrysanthemums.

Phosphoric Acid and Potash. Phosphoric Acid and Potash with $1\frac{1}{8}$ oz. Nitrate of Soda.

know, neat and cleanly and harmless (not acid, nor caustic), and every woman who cultivates vegetables and flowers should keep it on hand, to be used as occasion shall demand, as a top-dressing, say, at the rate of one-half to one teaspoonful to the square yard, or one rose bush.

Greenhouse Plant Food.

The use of rotted stable manure as a source of greenhouse plant food has been the custom for so many years that more effective forms of plant food make headway slowly; yet this rotted stable manure has many disadvantages. It always contains more or less weed seed as well as disease germs, and it supplies its plant food in available form very irregularly. Also, by fermentation it materially influences the temperature of the seed bed, a temperature we have no means of regulating. The Nitrogen it contains is not Nitrated, hence for forcing it cannot be safely relied upon. For greenhouse work, the fertilizer chemicals should be used, such as Nitrate of Soda, acid phosphate and sulphate of potash. They should always be used in such proportions that 100 pounds of ammoniate Nitrogen are always accompanied by 30 pounds of phosphoric acid and 70 pounds of actual potash. The quantity to be applied should correspond to about three-fourths of an ounce of Nitrate Nitrogen per square yard of surface; that is, to each square yard of bench, use about 5 ounces of Nitrate of Soda, 3 ounces of acid phosphate and 2 ounces of sulphate of potash. A mixture of these proportions may be dissolved in water and applied in small portions every few days, taking care, however, to cease applications with those plants it is desired to fully mature, as soon as the desired growth is made.

Lawns and Golf Links.

Good lawns are simply a matter of care and rational treatment. If the soil is very light, top-dress liberally with clay and work into the sand. In all cases the soil must be thoroughly fined and made smooth, as the seed, being very small, requires a fine seed bed. In the South, seed to Bermuda grass or Kentucky blue grass; in the North, the latter is also a good lawn grass, but perhaps a little less desirable than Rhode Island bent grass (Agrostis canina). Avoid mixtures, as they give an irregularly colored lawn under stress of drouth, or early frosts, or maturity. For Rhode Island bent grass use 50 pounds of seed per acre, Kentucky blue grass 40 to 45 pounds, and for Bermuda grass 15 pounds. If for any reason the soil cannot be properly prepared, pulverize the fertilizer very fine indeed. The grass should be mowed regularly and the clippings removed until nearly midsummer when they are best left on the soil as a mulch. For a good lawn, broadcast per acre in the spring enough of a fertilizer to supply 100 pounds of actual potash and 50 pounds of available phosphoric acid; also, use at the same time and in the same manner, a top-dressing of 300 pounds per acre of Nitrate of Soda. By the end of June repeat the Nitrate top-dressing, using only 100 pounds of the material. At any time through the growing season, yellow spots or lands should be given a light top-dressing of Nitrate, and thoroughly wet down if possible. Lawns are very different from field crops as they are not called upon to mature growth in the line of seed productions, and they may safely be given applications of Nitrate whenever the sickly green color of the grass appears, which shows that digestible or Nitrated ammonia is the plant food needed. These applications of plant food must be continued each year without fail, and all bare or partly bare spots well raked down and reseeded. If absolutely bare, these spots should be deeply spaded. On very heavy clay soils, and in low situations, a drainage system must be established.

Lettuce.

Culture.—Sow in hotbeds in March, and in the open ground as soon as it can be worked, and transplant to rows 8 inches apart. Sow in two weeks' time same varieties again, as also Cos, for a succession. In August sow any of the varieties. In October some of these may be planted in frames, to head in winter and early spring. Always sow thin, and thin out well, or the plants will not be strong. The last spring sowing had better be grown where sown, being thinned out to 6 or 8 inches apart. To have Cos in good order they must be sown in a hotbed early in the year, and transplanted to a coldframe, so as to have good plants to set out at the opening of the ground. They require tying for a few days, when grown to blanch. Lettuce requires good ground, enriched with thoroughly rotted manure and well pulverized. The after-culture should be close and careful, to secure the best results.

Mangolds.

Nitrate of Soda pays well for roots if applied at the rate of 200 pounds per acre. Use in two applications about ten days apart, the first not earlier than July. The Essex Agricultural Society found by experiment that 12 tons of farmyard manure and 300 pounds superphosphate gave a crop of nearly ten and one-half tons per acre, but when 200 pounds of Nitrate of Soda were added, the yield was increased to over 15 tons. The season was very unfavorable.

Formulas and Directions.

Melons, Cucumbers and Squash.

The remarks following upon the profitable fertilizing of melons, applies also to cucumbers, cantaloupes, squash and similar crops. All these crops do best on a rather light loam, or if heavier soils are used the drainage should be of the best. The method of growing these crops is too well known to require mention here. They should generally follow a clean culture crop, such as corn, as most of these plants cover the ground between rows so quickly that cultivation is limited to the first few weeks of growth. This is also an argument for a thorough preparation of the soil, deep plowing and deep working in preparing the hills.

As soon as the plants are well started, work into the soil about the hills a few ounces of a Nitrated ammoniate (Nitrate of Soda), a quantity per hill corresponding to 250 to 350 pounds of Nitrate of Soda per acre.

The best way is to scatter the fertilizer for two feet around the hills and rake it into the soil with a steel garden rake. This not only mixes the fertilizer with the soil, but it loosens the ground and kills all small weeds that are coming up.

If at any time the hills should show a sickly yellow, apply Nitrate at once, however late in the season.

Cucumbers, squash and cantaloupes should be planted in hills 5 feet apart each way, watermelons in hills 10 feet apart each way. Level culture rather than ridges is found to be more generally successful on very light soils.

Profitable Onion Cultivation.

Adaptability of the Onion to all Soils.

There is no crop that can be grown so successfully on a large scale, in such a variety of soil and climate, and that will respond more profitably to intelligent cultivation and fertilizing, than the onion. The American farmer has usually been willing to leave the growing of this savory vegetable almost entirely to the enterprising immigrant, who often makes more net profit at the end of the season from his five acres of onions than the general farmer makes on one hundred acres. The weeder and the improved wheel-hoe have made it comparatively easy to care for the crop; there is no reason why the progressive farmer who is looking about for a new money crop should not raise onions with ease and profit.

We shall consider here the growing of onions only as a field crop for the fall and winter market. The onion can be successfully grown anywhere in the United States where other vegetables thrive.

The reason that onions have not been more generally grown by farmers is owing to the mistaken idea that it is impossible to grow them without the application of vast quantities of stable manure, but onion-growing with the aid of chemical fertilizers is not only much cheaper, but the average crop is much larger. The excessive quantity of stable manure required to grow a maximum crop tends to make the land too open, when the great secret of onion culture is to get the land solidified. The ploughing under of so much bulky manure also tends to cut off the moisture supply from below, which is so important in the quick growth of crops of this nature and which can only be obtained by having the soil very compact and in fine tilth so as to promote the capillary movement of the soil moisture to the surface, where it may be retained for the use of the crop by means of frequent and shallow cultivation.

The advantage of using Nitrate of Soda instead of stable manure as the source of Nitrogen for this crop is plainly evident, as the Nitrate supplies the most beneficial ingredient contained in the stable manure (Nitrogen), and in a form in which it is not dependent upon soil bacteria and weather conditions to make it available for the young plants when they need it most. If it be necessary to add humus to the soil in the form of

Onions.

675 lbs. of Nitrate of Soda to the acre, in 6 applications. | 375 lbs. of Nitrate of Soda to the acre, in 4 applications. | No Nitrate.

stable manure it should, if possible, be applied a year in advance.

The presence of Nitrate at the outset enables the plant to start off with a good healthy root growth, whereby it is better able to take up later the other and more complex food elements.

If it cost $45.00 per acre for rent, ploughing, harrowing, seeding, weeding and cultivating to produce a crop of onions ready to harvest, then

A crop of 225 bushels per acre costs 20 cts. per bushel.
A crop of 450 bushels per acre costs 10 cts. per bushel.
A crop of 900 bushels per acre costs 5 cts. per bushel.

The latter yield is not at all unusual when the crop is properly fed with Nitrate of Soda and supplementary chemical fertilizers.

In the first place, the onion, contrary to the general belief, does not require any *special* kind of soil, such as muck, black sand, etc., but will do well on any good corn or potato soil, provided it is not too sour or so stony as to interfere with the early and frequent cultivation of the crop.

Even though a field is somewhat stony, it will pay to rake the stones into the dead furrows which should be about twenty feet apart, as the stones would make it impossible to do good work with the weeder and wheel hoe.

Necessity of Moisture in Soil.

In selecting your field for onions it is, of course, advisable to choose one that is likely to be affected as little as possible in the event of a severe drought, and it is for this reason that onions, cabbage and those crops that especially require large quantities of moisture during their growth are usually grown upon bottom lands.

Cultivation.

Ploughing for the onion crop should preferably be done in the fall to a depth of eight inches or more, leaving the soil in the furrow to be acted upon by the frost during the winter. It at the same time becomes more compact—the onion likes a solid seed bed. When for any reason the ploughing has to be done in the spring it should be done very early and worked down solid. The lands should be narrow, so that the numerous dead furrows will drain off excessive surface moisture early in the spring, as it is desirable to get the seed sown very early.

Free use of the Harrow and Pulverizer.

As soon as the condition of the soil in the spring will permit, it should be worked over with the harrow or pulverizer as deeply as the ground will allow and rolled with a heavy roller, which should be followed at once with a light harrow, which will loosen the surface soil and form a light mulch to help conserve the moisture. This operation should be repeated each week until it is time to sow the seed, which in this latitude is when the apple trees begin to bloom.

The seed should be sown with a hand seed drill about three-quarters of an inch deep and in rows about fifteen inches apart, using about six pounds of seed per acre.

In about five days after the seed is sown the field should be gone over with the weeder to destroy any weeds that have started to germinate near the surface, and again in three or four days, or before the onions come up. Always run the weeder across the rows.

After the onions are up so that you can see the rows, cultivate them carefully with the wheel hoe, using the sharp blades that are made for that purpose and going not more than one-half inch deep.

As soon as any more weeds appear to be germinating, go over the rows again with the weeder. The weeder may appear to be doing some damage, but if handled carefully there is no danger, as we have sown an extra pound of seed to allow for some being pulled out.

When the onions are about four inches high it will probably be necessary to weed them once by hand. This will not prove to be a tedious job if the weeder and wheel hoe have been used with good judgment.

Fertilizing.

Nitrate should be applied as follows: One hundred pounds scattered broadcast over the field within a week after the seed is sown and before the plants break through the ground, and two more applications broadcast consisting of 100 pounds each at intervals of two or three weeks, depending somewhat upon the appearance of the plants as to growth and color.

When to Apply Nitrate.

Generally speaking, the Nitrate should all be applied during May and June, though if a drought occurs in July, and the onions show signs of turning yellow at the tips, an extra dressing of 50 pounds per acre may be applied to advantage. In a wet season avoid putting it on late, as it might aggravate the tendency to produce a considerable number of scullions. It should only be applied when the plants are dry.

Use of Common Salt.

The onion is an alkali-loving plant, and, like asparagus, seems to have a peculiar fondness for salt. The results of experiments on widely different soils show that it nearly always responds profitably to an application of about 200 pounds of salt per acre. This guides us to the choice of kainit for this crop, as that product contains about 35 per cent. of chloride of soda, or common salt, which also aids in conserving the moisture in the soil. Good judgment must be used, however, as the kainit might have a harmful effect in a wet season on a low and naturally damp soil.

About 400 pounds of kainit per acre should be used, as a rule. It should be drilled into the entire surface of the ground early in the spring to a depth of at least three inches, for the kainit becomes fixed in the soil very quickly and should be rather deep, so as not to attract the feeding roots too near the surface. In case wood ashes or muriate of potash are used, the time of making the application should be the same. Most vegetables will give greatly increased returns from the use of chemicals if lime is employed in conjunction with them.

An application of 75 bushels per acre of ground quicklime has also proved preventive of onion smut.

If the soil is a medium heavy clay upland and not acid it is best to use the acid phosphate which contains, besides the phosphoric acid, about 50 per cent. of calcium sulphate (gypsum). This unlocks the natural potash in the soil.

The quantity of either to apply on ordinary soils is 1,000 pounds per acre very early in the spring, so that in preparing the ground it will become very thoroughly incorporated with the soil before the onion seed is sown.

The following table gives the actual field results of six years' experiments with fertilizers and seven years with manures at the rate of 30 tons per acre:

	Manure.	Chemicals.
Tons per acre, average.........	8.90	14.02
Market value per ton, average..	$18.16	$20.52

The crop grown with chemical fertilizers was 5.12 tons greater per acre, or a gain over the stable manure of nearly 58 per cent.; while the Nitrate crop averaged

$2.36 greater market value per ton, an advance over the manure-grown crop of 13 per cent.

Potatoes.

As is well known this crop must have a deep mellow soil, inclining more to sand than clay. The soil must be fined to a considerable depth, and kept free of weeds throughout the growing season. The most successful growers use only commercial fertilizers, and the amounts applied per acre range from 200 pounds to 1,000 and even 2,000. The fertilizer used should be high in potash, and this potash should be of such form as to be free or nearly free of chlorine, such as sulphate of potash. Early potatoes have a short season of growth, and the Nitrating action in the soil is insufficient to keep up a high pressure of growth during the earlier weeks. For this crop Nitrate of Soda is indispensable, top-dressing along the rows as soon as the plants are well above the ground and at the rate of 200 pounds per acre. For fall potatoes, an application of 50 to 100 pounds of Nitrate will be sufficient.

Heavy yields of potatoes can be secured only with good seed. Many of the most successful growers cold-storage their seed potatoes, that the vitality of the seed may not be reduced by freezing and thawing during winter. Seed should be cut to two or three "eyes," and only tubers of the best quality used. The rows should be about three feet apart, and the seed dropped fifteen inches apart in the rows.

Applying Fertilizers for Potatoes.

The land is first marked and a furrower run along the rows, making a furrow about four inches deep. In this furrow the fertilizer is applied, either by hand, or with a distributor, and well mixed with the soil. This is best done by running a cultivator along the row; or when a distributor is used, an attachment in the form of a small cultivator can be made to do the work at one operation. The potatoes are then dropped in the furrow and covered. If it is thought best to cultivate both ways, the land can be marked across the furrows after the fertilizer is applied.

Several experiments have been tried on the use of Nitrate of Soda as a top-dressing for early potatoes. This was applied at the rate of 100 pounds per acre, after the potatoes were up and started to growing. One year this treatment increased the yield of merchantable potatoes 100 bushels per acre, and the average of several years was 20 per cent. increase.

A private experimenter obtained results as below:

1. 400 pounds superphosphate and 300 pounds sulphate of potash...........245 bushels per acre.
2. Same as plot 1 with the addition of 200 pounds of Nitrate of Soda...........348 bushels per acre.

It is evident from the fact that the addition of 200 pounds of Nitrate of Soda produced 103 bushels more than the superphosphate and potash alone, that potatoes must have Nitrogen, and that in greater quantities than is supplied by the ordinary so-called "Complete Potato Manure."

Although the United States is a vastly larger country than Germany, we raised a potato crop in 1905 of only 260,741,294 bushels, as compared with the potato crop of 1,775,579,073 bushels which Germany raised. These bushels were 60 pounds each. The explanation of so immense a production of potatoes by Germany is found in the fact that the free distillation of alcohol for use in the arts has been a powerful stimulus to farm industry. Farming in some districts of the empire has been made possible only because of the ability of the people to produce cheap alcohol, and many farms owe their very existence to their distilleries.

Sweet Potatoes.

This crop prefers a soil lighter than Irish potatoes, but the preparation of the soil is much the same. It is an underground crop, and must not have to mine room for its roots. It should follow a clean cultivation crop, and be kept very clean itself. Too much ammoniate fertilizer interferes with the maturity of the crop, producing not only a large crop of useless vines, but also few marketable roots, and those of very poor keeping quality.

On this account the ammoniate plant food applied should not be of the ordinary kind which becomes slowly available, and continues to supply active Nitrated ammonia late in the season, thus delaying maturity to such extent that the crop is injured by cold weather.

The New Jersey Experiment Station made some experiments in Gloucester County, and the following table shows the results:

Experiments with Fertilizers on Sweet Potatoes.

	Kind of fertilizer and quantity per acre.	Cost of fertilizer.	Bushels per acre. Large.	Small.	Total.
1.	No manure................		157	51	208
2.	320 lbs. bone-black, 160 lbs. muriate of potash........	$7.70	205	36	241
3.	200 lbs. Nitrate of Soda, 320 lbs. bone-black, 160 lbs. muriate of potash........	12.34	270	58	328
4.	20 tons stable manure......	30.00	263	61	324

It will be seen that the addition of Nitrate of Soda to the bone-black and potash gave an increase of 65 bushels per acre, and that the Nitrate, bone-black and potash, together costing $12.34, produced a little larger yield than 20 tons of manure, costing $30.00.

"Another point of considerable importance, since it has reference to the salability of the potatoes, was noticed at the time of digging, viz.: That those grown with chemical manures alone were bright and smooth of skin, while at least one-third of those grown with barn-yard manure were rough and partially covered with scurf."

Tomatoes.

Tomatoes are successfully grown on all soils, excepting very light sand or a very heavy clay; with irrigation, they may be grown profitably on light sandy soils. The soil must be plowed deeply, and thoroughly worked. It is generally best to buy plants from a reputable grower, unless the crop is planted on a large scale for canning, in which case plants are grown under special instructions of the cannery. The main feature in profitable tomato growing is to maintain a rapid, steady growth. The soil should be kept pulverized at the surface as a mulch, for the crop uses enormous quantities of water. The plants continue bearing until frost, hence the earlier fruiting commences the heavier the crop through simply having a longer period in bearing. Ten tons per acre is by no means an unusual yield, but plant food must be used with a free hand.

The New Jersey Experiment Station made an experiment with different forms of ammoniates on this crop, and the Nitrated ammoniate (Nitrate of Soda) not only produced the largest crops, but also the largest quantity of "early" tomatoes, and the lowest per cent. of culls. The yield was twelve per cent. greater than that from sulphate of ammonia, and sixty-eight per cent. greater than that from dried blood.

As soon as the plants are well rooted, top-dress with 200 to 300 pounds of Nitrate of Soda per acre, worked into the soil about the plants. Farm-yard manure may be used on this crop when grown for canning, but the results are always doubtful, as a continued stretch of dry weather may injure the crop through drying out the soil by the large quantity of vegetable matter mixed with it. However rich the soil may be, or however freely chemical fertilizers may have been used, the top-dressing of Nitrate will be found to have increased the fruiting power of the plants, and to have also added to the flavor and color of the fruit.

It has been found by experiments made at the New Jersey Experiment Station for a period of three years, that Nitrate of Soda, applied when the plants were set out, greatly increased their growth early in the season and produced a much larger crop of early ripe fruit than either barn-yard manure, "phosphates," or no manure at all.

Experiments with Fertilizers on Tomatoes.

	Kind of fertilizer used and quantity per acre.	Cost of fertilizer.	Yield per acre in bushels.	Value of crop.
1.	No manure................	.....	613	$208.61
2.	160 lbs. Nitrate of Soda....	$4.00	838	300.64
3.	160 lbs. muriate of potash, 320 lbs. bone-black.......	7.20	649	252.92
4.	160 lbs. Nitrate of Soda, 160 lbs. muriate of potash, 300 lbs. bone-black...........	11.20	867	301.25
5.	20 tons barn-yard manure...	30.00	612	218.27

It will be noticed that 160 pounds of Nitrate of Soda, costing $4.00, made an increase in the value of the crop of $92.03 per acre over the unfertilized land, and $82.37 over the land where 20 tons of barn-yard manure, costing $30.00, was used. It will also be noticed that the addition of phosphate (bone-black) and potash had little or no effect. This does not indicate that tomatoes do not require phosphoric acid and potash, but that enough of these elements of plant food was already in the soil.

The yield of early tomatoes was very decidedly increased by the use of Nitrate of Soda, both alone and together with phosphoric acid and potash.

NEW JERSEY EXPERIMENT STATION.

Bulletin No. 91.

Some of the early work of this Station was with fertilizers for tomatoes. The results in detail are given in the Bulletin, but it showed that Nitrate of Soda was particularly active with this crop and produced a larger increase than any other single ingredient. An application of 160 pounds per acre caused an increase of as much as five tons of tomatoes.

There has been much valuable work conducted upon the use of Nitrogenous Fertilizers with various crops, and particularly vegetables. This work has proven that this plant food is a potent factor in increasing the yields and improving the quality.

Turnips and Swedes.

Nitrate is applied for this crop quite in the same manner as for mangolds. Dr. Macadam reported to the Arbroath Farmers' Club a gain of 37 per cent. in yield from the use of 336 pounds of Nitrate of Soda per acre.

An experiment conducted by Dr. Munroe, of Downtown Agricultural College, Salisbury, gave a return of nearly twenty and one-half tons per acre, from an application of 600 pounds of Nitrate per acre, supplemented by phosphoric acid and potash. The Nitrate was used in three applications. An application of 300 pounds of Nitrate resulted in a yield of thirteen and one-third tons per acre.

Increased Yield.

FERTILIZERS FOR FRUITS.

Bulletin 66, Hatch Massachusetts Experiment Station.

Lack of Nitrogen in the soil is detrimental to the size and quality of the fruit. The cheapest and most available ammoniate is Nitrate of Soda. A few cents' worth applied to each tree will give the largest possible yield of choicest fruit, returning many times its cost.

Fertilizers for the apple: The results show the most improvement where Nitrate of Soda was applied. For apple trees in grass the following fertilizer is recommended: Nitrate of Soda 1 to 5 pounds, sulphate of potash 1 to 5 pounds, S. C. phosphate rock, 4 to 10 pounds; the quantity used to be varied according to the size of the tree.

Nitrate of Soda on Apples.

Fertilizers for the peach: The fertilizer recommended, depending upon the size of the trees, is substantially the same as for apples, except that the phosphate rock is reduced one-half for the earlier stages of growth, remaining the same as for

Peaches.

apples in the later stages. Nitrate of Soda should not be applied until just as the trees are beginning to grow.

Nitrate of Soda for Fruits Generally.

Fertilizers for other fruits: For all perennial fruits, as well as shrubs and plants, the fertilizer used should be largely available in the early part of the season, as a preventive to winter injuries. Nitrate of Soda is the most desirable form of ammoniate.

The Rational Use of Chilean Nitrate in California

Some time since horticulturists in convention in Los Angeles discussed the question of the accumulation of Black Alkali in the soil.

One speaker made the statement that the use of Chilean Nitrate would result in such alkali accumulation—stating that in England this had become the case, and that English farmers were avoiding the use of Nitrate.

The incorrectness of this latter statement is shown by the fact that the use of Chilean Nitrate increases year by year in England, and it is coming to be more and more appreciated there, as well as on the continent of Europe.

In fact, everywhere in the world where there is progressive and enlightened experiment work, the unique qualities of Chilean Nitrate are putting it ahead of every other Nitrogenous plant food. No reputable authority in the world hås ever advocated such large quantities of Chilean Nitrate per acre as would result in any abnormal accumulation of alkali. Moreover, the use of acid phosphates, associated as they frequently are with sulphate of lime, converts any alkali residue into harmless forms of soda. Besides, the vast majority of soils in the United States, probably 95 per cent., have a tendency to grow acid rather than to grow alkali; and Chilean Nitrate is, therefore, highly beneficial in such cases. Chilean Nitrate is really needed to help neutralize these acid residues.

The use of potash salts tends to leave acid residuals, and when phosphates and potashes are used rationally, and in quantities suitable for normal plant feeding, the question of Chilean Nitrate leaving abnormal amounts of alkali residues becomes a purely fanciful one, and is not worth the serious attention of a practical business horticulturist or farmer.

In all our literature, we recommend the rational and not the irrational use of fertilizers; *i. e.*, normal amounts of the three elements of fertility. We never recommend the use of Chilean Nitrate alone, except at the rate of 100 or 200 pounds per acre, which is a trifling tonnage application; and we always advise, when larger amounts are used, that the horticulturist or farmer use as much or more in quantity of the phosphates and potashes.

On the other hand, as previously stated, in the case of 95 per cent. of our soils, the use of acid phosphate tends to leave acid residuals, as sometimes the potash salts likewise do. The actual need of Chilean Nitrate is, therefore, quite obvious.

The vast majority of farm lands of our country, where so-called "Complete" Fertilizers have been used, have the tendency to become sour and acid; and Chilean Nitrate could not only be used indefinitely with an extremely beneficial effect for this particular purpose, but there is an immediate general need for it.

An acre of ground one foot deep is the active service part of the soil, and, to a large extent, its chemical composition determines its usefulness. This service soil weighs on an average 2,000 tons per acre.

There is enough sulphate of lime or gypsum present, as well as acid, in the average acid phosphate, to materially help the black alkali of many alkaline soils, but gypsum alone may be used also for correcting alkali.

Since we never recommend the use of Chilean Nitrate alone, except at the rate of from one hundred to two hundred pounds per acre, this trifling amount could have no material influence whatever in increasing the alkali content of soils. For two hundred pounds of Chilean Nitrate per acre is a mere trifle for producing alkali, hence even the continued use of Nitrate under rational methods of fertilizing, would not add to, but rather diminish the quantity of alkali in the soil, for the associated gypsum and acid phosphate loosen heavy clay soils which need improvement in texture.

In this connection, it is important to observe that care must be exercised, in soils containing black alkali, to avoid materially increasing the content of carbonate or bi-carbonate of lime, since this would help promote the destruction of humus. It is, therefore, suggested for these particular soils, that the large and constant use of lime be avoided. When lime is needed, have your soil examined by an expert, and do not put on any more lime in any form than advised for your particular case. In other words, take good care to preserve your humus. Do not destroy it by excessive liming on any account. Neither wetness nor stickiness will result from the rational use of Chilean Nitrate. The productivity of all soils may be increased by the right use of it.

All arid soils lack nitrogen on account of having but little natural humus in them, so the application of Chilean Nitrate gives good crop increases.

What Burbank Says:

"After testing a great variety of fertilizers on my orchard and experimental grounds, I find that the Nitrate of Soda and Thomas slag phosphate have given the best results at the least expense, and I shall not look further at present, as my trees, bulbs, plants, flowers and fruits have been, by the use of about 150 pounds each per acre, nearly doubled in size and beauty in almost every instance. The above-named fertilizers have more than doubled the product of my soil at a very small outlay per acre.

Where the Nitrate of Soda is used, I find a greatly increased ability in trees to resist drought, and lack of cultivation."

"Luther Burbank is the greatest originator of new and valuable forms of plant life of this or any other age," says David Starr Jordan, President of Leland Stanford Junior University, California.

Winter Spraying With Solutions of Nitrate of Soda

By W. S. Ballard, *Pathologist, Fruit-Disease Investigations, Bureau of Plant Industry*, and W. H. Volck, *County Horticultural Commissioner of Santa Cruz County, California.*

These investigations were conducted in co-operation between the Office of Fruit-Disease Investigations of the Bureau of Plant Industry and the Office of the County Horticultural Commissioner of Santa Cruz County, located at Watsonville, Cal. The writers' names appear above in alphabetical order.

Introduction

Recently several investigators have reported results in shortening the rest period of a number of woody plants by immersing the dormant shoots in weak nutrient solutions or by injecting solutions of alcohol, ether, and various acids into the twigs. These experiments have been conducted in the laboratory with short cuttings of the plants. The effect of such treatment has been to force the dormant buds out several days ahead of the normal opening period.

During the last two years the writers have obtained similar and additional results on a much larger scale by spraying dormant fruit trees with strong solutions of certain commercial fertilizers, especially Nitrate of Soda. Since these experiments have been conducted on the entire trees in the orchard, it has been possible to observe the effects throughout the whole season. The investigations have not yet been carried far enough to permit drawing any conclusions regarding the physiologic action of such spraying, but because of its practical value these preliminary results seem deserving of attention at this time.

Experiments in 1912

In the course of the investigations of the writers on the control of apple powdery mildew in the Pajaro Valley, Cal., it became evident that the general vigor of the tree and the thriftiness of the foliage growth had much to do with the success of the summer spraying treatment for the control of the mildew, and after a number of experiments in applying plant-food materials to the foliage in the form of summer sprays, and after seeing that certain crude-oil emulsions used as dormant sprays had a marked effect in stimulating an increased vigor of the trees the following spring, it was decided to try the effect of a strong solution of Nitrate of Soda as a winter or dormant spray. Caustic potash (potash lye) was also added for the purpose of giving the spray an insecticide value. The mixture was prepared according to the following formula:

Nitrate of soda	50 pounds
Caustic potash	7 pounds
Water	50 gallons

The experiment was conducted in a Yellow Bellflower apple orchard owned by Mr. O. D. Stoesser, of Watsonville, Cal. This orchard is situated about 5 miles from the ocean shore and is in a district that is more subject to ocean fogs and trade winds than is the main portion of the Pajaro Valley. It is a common characteristic of the numerous orchards of Yellow Bellflower apples of this particular district that they bloom abundantly, but set only a partial crop. The trees are on a deep sedimentary soil and grow well.

Seven 12-year-old trees were sprayed on February 2, 1912. The application was very thoroughly made, so that all of the small twigs were drenched. About 7 gallons of spray solution were applied to each tree. Adjoining this row on one side was a check row of seven trees which received no winter spraying, and on the other side were several rows of seven trees each which received various applications of crude-oil emulsions and soaps. For the purpose of gaining some idea of the effect of Nitrate of Soda used as a fertilizer, 50 pounds were applied as a surface dressing to one vigorous tree selected from the row adjoining the Nitrate-sprayed row. This fertilizer was later plowed in and washed down by the rains.

Effects on Blossoming and on the Foliage

Notes taken at the time the trees were coming out in the spring show the following results:

April 7, 1912. Trees in the row sprayed with Nitrate of Soda and lye are well in bloom, while those in the check row adjoining and in the remainder of the unsprayed orchard are showing only an occasional flower fully opened.

April 14, 1912. The relative advancement of the row sprayed with a solution of Nitrate of Soda and lye and the check plat is the same as noted on April 7. The Nitrate-sprayed trees are nearly in full bloom, whereas comparatively few blossoms have opened on the check plat.

When the check row had reached full bloom, the row sprayed with a solution of Nitrate of Soda and lye was practically out of bloom.

Thus, the Nitrate spraying advanced the blossoming time about two weeks ahead of the normal period. It is characteristic of the Yellow Bellflower variety of apples in the Pajaro Valley that the foliage buds come out early, so that by the time the full-bloom period is reached the trees are showing a considerable amount of young foliage. The Nitrate spraying produced a change in this respect. While the flower buds were greatly stimulated in coming out, the foliage buds were not so much affected, and the result was that when the trees sprayed with a solution of Nitrate of Soda and lye were in full bloom and two weeks in advance of the check trees in that regard, their foliage condition was relatively nearer that of the check. Plate L shows the comparative stages of the Nitrate-sprayed and the check trees at that time. A decided contrast will be seen in the relative advancement of the bloom on the tree sprayed with Nitrate of Soda (Pl. L, fig. 1)* as compared with the check tree (Pl. L, fig. 2).* This contrast is shown more in detail in Plate LI, in which figure 1 shows a branch from a Nitrate-sprayed tree, while figure 2 shows one from a check tree. Both branches were collected on the same day. An examination of the figures in Plate L will show that the advancement of the foliage on the Nitrate-sprayed tree is comparatively less marked than that of the bloom. This same condition is shown in detail in Plate LI, in which it will be seen that there is relatively little difference in the advancement of the foliage of the sprayed and unsprayed branches. Later in the spring, however, the

* For plates, see original article.

effect on foliage growth became more pronounced, and the sprayed trees assumed a more vigorous, green appearance than the check trees. The single tree that received the 50 pounds of Nitrate of Soda applied to the soil showed no greater vigor than the check trees.

Both the row sprayed with Nitrate of Soda and the check row received summer sprayings directed toward the control of apple powdery mildew and of codling moth and various other insect pests. While the treatment of the two rows was not the same, there was no essential difference in the results—that is, the crop loss from codling moth and other insect pests did not exceed 1 per cent. on either plat and there was no damage to the fruit from summer spraying. It is therefore, evident that the difference which showed up in the crop production of the two rows must be attributed to the winter Nitrate spraying.

Crop Results

The check row of seven trees, which received no winter spraying but which was properly protected by summer sprayings, produced 8 loose boxes of fruit at picking time. On the other hand, the adjoining row, sprayed in February with the solution of Nitrate of Soda plus lye, produced a total of a little over 40 boxes. Thus, the winter Nitrate spraying increased the crop production to fully five times that of the unsprayed row. Similar adjacent plats, which were winter-sprayed with various crude-oil emulsions and soap sprays, produced crops varying from 5 to 9 boxes per plat. The single tree which received the 50 pounds of Nitrate of Soda applied as a fertilizer gave no increased production, whereas none of the trees in the Nitrate-sprayed row failed to respond.

Regarding the single, heavily fertilized tree, it might be stated that in addition to its showing no increase in production, the tree bloomed no earlier than normal, there was no improvement in the growth and no change in its general appearance throughout the growing season of 1912, and in the spring of 1913 it came out normally and not differently from the other trees in the same row, being one of the trees in a check plat. The tree is still in normal condition and shows no noticeable effect from the heavy fertilizing. The orchard is not irrigated, and the rainfall has been much less than normal during the last two years.

Attention might again be called to the conditions under which these results were obtained—namely, thrifty-growing trees in a deep residual soil and having the characteristic of blooming abundantly each year but setting only a shy crop. Even the 40 boxes produced by the Nitrate spraying does not represent the full crop that such trees should bear, but the fourfold increase much more than paid for the cost of spraying, and the possibility remains of still further increasing that production by similar treatment in following years.

Experiments in 1913

The one small experiment on seven trees in 1912 did not furnish sufficient grounds for drawing any general conclusions as to the applicability of winter Nitrate spraying, but the striking results obtained opened a wide field of inquiry. For instance, potash lye was added to the solution of Nitrate of Soda in the experiment of 1912, so the questions arise as to whether the lye was necessary and whether an acid medium would increase or decrease the effect of the Nitrate of Soda; also, would a weaker Nitrate solution prove as effective and would other nitrogen-bearing fertilizer materials, such as lime Nitrate, lime cyanamid, and sulphate of ammonia, give similar results? Following along this line it would be interesting to know what effect, if any, the other fertilizer elements, potash and phosphoric acid, might have when applied as sprays, and finally, what results might be obtained from a similar application of other substances not ordinarily considered as having any particular fertilizer value.

Experiments intended to answer these and a number of other more or less important questions were started in February, 1913, in the same orchard in which the previous year's work was done. Eleven 13-year-old trees were used in each plat. A frost occurred at the time the fruit was setting which ruined the crop and made it impossible to obtain results in crop production. Data were obtained, however, on the effect of the various sprays on the blossoming of the trees in the spring, and the notes taken may be summarized as follows:

The plats sprayed with Nitrate of Soda at the rate of 1 pound to the gallon came into bloom earlier than the check trees, just as they had done in 1912. This effect was more marked in the cases in which lye was added to the Nitrate solution than when the plain water solution was used—that is, the addition of lye in the proportion of 16 pounds of caustic soda in 100 gallons of spray solution increased the action of the Nitrate of Soda in bringing the trees out earlier. Caustic soda appeared to be just as effective as caustic potash. Nitrate of Soda used at the rate of half a pound to the gallon, either with or without the addition of lye, was not nearly so effective as a solution of 1 pound to the gallon. A solution of one-fourth of a pound to the gallon, with lye added, had practically no effect. Nitrate of Soda, at the rate of 1 pound to the gallon, to which oxalic acid was added in the proportion of 50 pounds to 125 gallons of solution, produced results similar to Nitrate of Soda plus lye, so far as the effect of hastening the blooming period is concerned. Lime Nitrate, 130 pounds in 100 gallons of water, and lime cyanamid, 92 pounds in 100 gallons of water, stimulated an earlier blooming of the trees, and subsequent experiments will probably put these substances in a class with Nitrate of Soda. Normal Yellow Bellflower apple blossoms have considerable pink color, and it was interesting to note that when the trees sprayed with the lime cyanamid came into bloom the flowers were nearly white. The effects from sulphate of ammonia were not nearly so marked as those from Nitrate of Soda. These various nitrogen-bearing fertilizer substances were used in such strengths as to carry relatively the same quantities of nitrogen per gallon. Sulphate of potash had some effect in stimulating an early blooming, but double superphosphate did not. Of a number of other substances tried, common salt used at the rate of 68 pounds to 100 gallons of water produced a distinct effect.

It will be borne in mind that the above remarks apply simply to the effects of the various sprays in causing an earlier blooming of the trees, but since this early blooming was a striking characteristic of the Nitrate-sprayed trees of 1912, which showed a fourfold increase in production, it seems permissible to conclude that this effect on the fruit buds is some criterion of what might have been expected in the way of crop increase had not the fruit been lost by frost.

The row of seven trees used in the Nitrate experiment of 1912 was left unsprayed this last season for the purpose of determining whether the Nitrate effect would continue to the second year. It was noticed that the fruit buds on these trees were particularly large and plump, and somewhat unexpectedly at blossoming time these trees came into bloom several days ahead of the check rows. The bloom came out very uniformly all over the trees, whereas ordinarily it is considerably delayed on the windward side. Also, the individual blossoms were conspicuously larger than those of any other plat, and, so far as could be judged at the time the frost occurred, a good crop was setting all over the trees. Thus, it appears that this effect of the Nitrate of Soda had continued over to the second year.

At present, all things considered, the best results have been obtained by using a mixture made up as follows:

Nitrate of Soda	200 pounds
Caustic Soda	25 pounds
Water	200 gallons

In preparing this solution the required quantity of water was placed in the spray tank and the agitator started. When the water was in motion, the required weight of Nitrate of Soda was added gradually. Any large lumps were first broken up into pieces about the size of hen's eggs. The caustic soda was then added, and in about 15 minutes from the time the preparation was begun the mixture was ready for applying.

The trees were very thoroughly sprayed on all sides, so that all of the small twigs were drenched. The best results so far obtained have come from the spraying applied about the 1st of February. Of course, weather conditions must be taken into consideration. A rain immediately following the application will wash much of the material off of the trees, and it is probable that at least a week of clear weather should follow the spraying, in order to insure good results.

In all of this work on spraying a solution of Nitrate of Soda on the trees a considerable quantity fell to the ground, and the question will be raised as to whether the various effects observed have not been simply the result of the fertilizer action of the Nitrate on the soil. About 7 gallons of the solution were used in spraying each tree, and if the whole of this had gone on the ground it would have amounted to about 7 pounds of Nitrate of Soda per tree. The single tree in 1912 that had the 50 pounds of Nitrate applied to the soil, therefore, received over seven times the total quantity applied to any single sprayed tree. As has been previously stated, this single, excessively fertilized tree bloomed no earlier than normal, produced no increased crop, and showed no improvement in general vigor and appearance; whereas, none of the trees in the sprayed plat failed to respond in all of these particulars. Of course, this single tree test in the application of Nitrate to the soil is too small an experiment to permit concluding positively that the effects that we have reported from the spraying experiments are of an entirely different nature and belong in a different category from those produced by the ordinary soil application of Nitrate. A careful consideration of the results of ordinary orchard practice in fertilizing seems to make it plain that there is no similarity between them and the results from spraying. For instance, in the usual practice of applying Nitrate of Soda as a fertilizer to apple orchards in the region of Watsonville, Cal., a winter or early spring application does not force the bloom out 10 days or 2 weeks ahead of the normal opening period and has had no measurable effect in increasing the set of fruit that same year. The fact that the addition of caustic soda or oxalic acid to the Nitrate spray augments these various effects further emphasizes the difference between the results from spraying and the ordinary results from the application of fertilizer. Caustic-soda solution alone applied as a spray has no effect on the time of blooming or the crop production.

Experiments of Growers in 1913

Yellow Bellflower Apples

During the past season a number of growers made more or less extensive tests of the spraying with Nitrate of Soda. An aggregate of several hundred acres of Yellow Bellflower apples was sprayed with Nitrate of of Soda plus caustic soda, but practically all of this acreage was in the same district in which the writer's experiments were conducted, so the crop was lost by frost. It was noticeable during the past summer, however, that the foliage in such orchards as received very thorough winter Nitrate sprayings had a better appearance than in years past, due apparently to the effect of the Nitrate. One orchard, that of MacDonald & Sons, is located in a district that practically escaped frost damage, and the results obtained indicated a marked crop increase in consequence of the spraying. The entire orchard, with the exception of a few trees, was sprayed with various combinations of Nitrate of Soda and lye, and, while no exact data on the production of the unsprayed trees as compared with the rest of the orchard was obtained, the amount of fruit on the trees indicated that the spraying had produced a marked increase. This conclusion was more reliably substantiated by comparing the total orchard production this year with that of previous years.

Sweet Cherries

Mr. A. W. Taite, of Watsonville, sprayed portions of two blocks of Napoleon (Royal Ann) cherries with Nitrate of Soda, 1 pound to the gallon, to which caustic soda was added at the rate of 25 pounds to 200 gallons. Unsprayed rows adjoining the sprayed ones were left in each block. In one case the sprayed trees were distinctly advanced over the check trees in coming into bloom. In both cases there was an increase in the foliage growth and a consequent improvement in the appearance of the trees. No effect on crop production could be noticed, though it is possible that treatment in successive years may bring such results.

Pears

For our observations on pears the writers are indebted chiefly to Mr. George Reed, of San Jose, who carried out extensive tests in the orchards of the J. Z. & G. H. Anderson Fruit Co. The spraying was done about the 1st of February and the following notes are taken largely from Mr. Reed's observations:

Clairgeau.—Four rows of about 40 trees each were sprayed with commercial lime-sulphur (33% Baumé) diluted 1 to 9. Adjoining these were four rows sprayed with lime-sulphur solution diluted 1 to 9 and to which was added Nitrate of Soda at the rate of 1 pound to the gallon of the diluted spray. The rows sprayed with the combined solution of Nitrate of Soda and lime-sulphur came into bloom about a week ahead of those that received the lime-sulphur solution alone. The development of the fruit on these Nitrate-lime-sulphur solution rows continued to show an advancement of about a week throughout half the growing season, and at picking time the fruit was greener and hung on better than that of the plain lime-sulphur-solution rows. Both plats bore a full crop, so there was no opportunity for observing any effect on production. The Clairgeau variety blooms early, and the further advancement due to Nitrate spraying might result in frost injury in some localities. The fruit ordinarily has a habit of dropping off during the latter part of the growing season. This difficulty, however, was largely eliminated on the Nitrate-sprayed rows.

Comice.—The major portion of the block was sprayed with a plain water solution of Nitrate of Soda at the rate of 1 pound to the gallon. A small portion was sprayed with commercial lime-sulphur solution, diluted 1 to 9, with Nitrate of Soda added at the rate of 1 pound to the gallon of diluted spray. Through a misunderstanding the men doing the spraying left no check rows in this block, so that crop data could not be obtained. However, Mr. Reed's exact knowledge of the previous production of this block as a whole indicates that the marked increased production this last season was more than probably due to the Nitrate spraying. The Comice is a relatively shy bearer, and a valuable pear commercially, so that any increased production that could be obtained by Nitrate spraying would be much appreciated by the grower. One portion of the block that regularly produces less than the remainder gave a good crop this year, and it appeared that the addition of the lime-sulphur solution augmented the effect of the Nitrate of

Soda just as the addition of lye has done in the experiments of the writers.

Glout Morceau.—A block of Glout Morceau pears was sprayed with the combination of lime-sulphur solution, diluted 1 to 9, plus Nitrate of Soda 1 pound to the gallon of diluted spray. This block had never produced a full crop, and while no unsprayed checks were left, the increased production would appear to be due to the Nitrate spraying.

Winter Nelis.—A block of Winter Nelis pears was sprayed with a solution of Nitrate of Soda 1 pound to the gallon of water. No lime-sulphur solution was added in this case. No check rows were left, and a frost destroyed a large percentage of the fruit after it had set. However, at that time the trees were carrying the largest crop they had ever produced, and again it would appear that the Nitrate spraying had had a beneficial effect. The trees came into bloom about 10 days ahead of normal opening period.

Discussion on Results and Summary

It is not the writers' intention to convey the impression that dormant spraying with Nitrate solutions will solve the problem of shy bearing of fruit trees nor offer a more advisable method of applying nitrogen fertilizer. The purpose of this paper is simply to present the results as they now stand.

It is evident that, at least under certain conditions, some varieties of apples and pears that are more or less self-sterile may have their crop production materially increased by dormant spraying with solutions of Nitrate of Soda plus lye. The combination of a solution of Nitrate of Soda and lime-sulphur is apparently capable of bringing similar results.

Actual quantitative data on increased production from spraying with a solution of Nitrate of Soda are available from only one source, that of the first experiment on Yellow Bellflower apples in 1912. No production records were obtainable from the various tests made by growers during the season of 1913 but the one test on Yellow Bellflower apples and several others on pears indicate that such an increase had undoubtedly been brought about. It is considered that the growers' knowledge of the crops of the previous years as compared with that of this year furnishes a basis for conclusions that are at least corroborative.

That Nitrate spraying of dormant trees will bring about an earlier blooming of certain varieties of fruit is a satisfactorily established fact, which has been demonstrated on Yellow Bellflower apples at Watsonville, Cal., and on various varieties of pears at San Jose, San Juan, and Suisun, Cal., during the past season. How generally this statement will apply to other varieties of apples and pears and in other localities remains to be determined. Results on stone fruits have not been as striking as those on pears and apples, but it is possible that stronger solutions, earlier spraying, or a repetition of the spraying in successive years may bring about such results.

The greater danger of injury from frost that might result from forcing trees into bloom earlier than normal would have to be taken into consideration in making practical use of Nitrate spraying in winter.

Aside from the effect on crop production, there has also been a very noticeable improvement in the color, abundance, and vigor of the foliage, and it seems possible that Nitrate spraying of dormant trees may be a valuable supplement to the ordinary fertilizer practices in obtaining quick results in orchards suffering from lack of nitrogen.

The writers will make no attempt at present to explain the peculiar effect of Nitrate of Soda in increasing the production of more or less self-sterile varieties of fruits, or in improving foliage growth. The similarity between the writers' results in forcing dormant buds by winter Nitrate spraying and the results obtained by other investigators by treating cuttings with various weak solutions has been mentioned. In experiments of the writers, however, a more or less lasting effect on the vigor of the foliage and also some valuable results in increasing crop production have been obtained. It furthermore appears that the effects obtained by spraying with a solution of Nitrate of Soda may continue over to the second year, as shown by the original plat of 1912, which was left unsprayed in the winter of 1913.

The effects of the Nitrate spraying seem to be proportional to the strength of the solution employed and the thoroughness with which it is applied. The addition of caustic soda materially increases this action.

Small Fruits.

Under this head we treat of blackberries, currants, gooseberries and raspberries. Strawberries are treated separately. All these small fruits are commonly grown in the garden, generally under such conditions that systematic tillage is not practicable. For this reason such plant food essentials as may exist naturally in the soil become available to the uses of the plants very slowly. This is true of the decomposition of animal or vegetable ammoniates as of phosphates and potashes. Consequently, small fruits in the garden suffer from lack of sufficient plant food. All these plants when planted in gardens are usually set in rows four feet apart, the plants about three feet apart in the rows; about 4,200 plants to an acre. In field culture, blackberries are usually set four feet apart each way.

So far as possible, small fruits should be cultivated in the early spring, and all dead canes removed. Work into the soil along the rows from 300 to 600 pounds of phosphate and potash; when the plants are in full leaf, broadcast along the rows from 200 to 400 pounds of Nitrate of Soda, and work in with a rake. If at any time before August the vines show a tendency to drop leaves, or stop growing, apply more Nitrate. Small fruits must have a steady, even growth; in most cases unsatisfactory results can be directly traced to irregular feeding of the plants. In field culture, the crop must be tilled quite the same as for corn; in the garden in very dry weather irrigation should be used if possible. The yield per acre is very heavy, and, of course, the plants must be given plant food in proportion.

Raspberries, Currants, Gooseberries.

Sow broadcast, in the fall, a mixture of, say, 350 pounds of superphosphate and 100 pounds muriate of potash per acre. This can be done, if the rows are six feet apart, by sowing a large handful at every two steps on each side of the row. Raspberries and gooseberries should have a small handful, and currants a large handful to each bush. This should be cultivated in, if possible, early in the spring. Sow Nitrate of Soda in the same way. It will pay to put on as much Nitrate as you did superphosphate and potash, but if you do not want to put on so much, use smaller handfuls. If the superphosphate and potash have not been applied in the fall, sow the mixture in the spring at the same time the Nitrate is sown and cultivate it in, early.

Strawberries.

This plant requires a moist soil, but not one waterlogged at any time of the year. A light clay loam, or a sandy loam is preferable. There are several methods of cultivation, but the matted row is generally found more profitable than the plan of growing only in hills. While some growers claim that one year's crop is all that should be harvested before ploughing down for potatoes, as a matter of fact the common practice is to keep the bed for at least two harvests. In selecting plants, care should be exercised to see that pistillate plants are not kept too much by themselves, or the blossoms will prove barren. The crop is a heavy consumer of plant food, and the soil cannot be made too rich. Farmyard manure should never be used after the plants are set out, as the weed seeds contained therein will give much trouble, especially as the horse hoe is of little use in the beds. Use from 400 to 800 pounds of phosphate, applied broadcast immediately after harvest; in the spring, as soon as the strawberry leaves show the bright, fresh green of new growth, apply broadcast 200 pounds of Nitrate of Soda to the acre. In setting out a new bed, scatter the fertilizer along the rows and cultivate in, before the plants are set out.

Strawberries.

It is well to scatter the fertilizers for a foot on each side of the rows so that the runners will have something to feed upon. In the spring, sow Nitrate of Soda on the bed broadcast at the rate of about 200 pounds per acre. On old beds, sow the mixture broadcast in the fall and an additional 200 pounds of Nitrate per acre in the spring.

Prof. W. F. Massey writes: "I top-dressed an old strawberry bed in its fifth year of bearing with 300 pounds Nitrate of Soda per acre. I had intended ploughing it up the previous summer as it was in an exhausted condition and foul with white clover and sorrel.

"The effect was amazing, for this bed of an acre and a quarter, from which I expected almost nothing, gave seven thousand quarts of berries.

Figs.

After investigating the requirements of the fig, Professor George E. Colby, of the University of California Experiment Station, says:

> "The fig leads among our fruits in its demand upon the soil for Nitrogen. Thus we find for the southern localities especially, the same necessity of early replacement of Nitrogen in figs and stone fruit as for Orange orchards, and partly for the same reason, viz., that California soils are usually not rich in their natural supply of this substance."

Nitrate of Soda will furnish the necessary Nitrogen in its most available form, and at less cost than any other material. It will probably be best to use in addition to the Nitrate an equal quantity of bone meal phosphate, say two pounds of each per tree.

Grapes.

Grape plantations should be located and planted by an expert, and one, too, who has had experience with the locality selected as the site of the vineyard. The treatment of the young plants is a matter of soil and climate, and for which there are no general rules. When the vines have reached bearing age, however, their fertilization becomes a very important matter. The new wood must be thoroughly matured to bear next year's fruit, and an excess of ammoniate late in the season not only defeats this object, but also lessens the number of fruit buds. Potash and phosphoric acid must be used freely, about 50 pounds of potash and 60 pounds of available phosphoric acid to the acre. This is not a crop for ordinary commercial fertilizers. The fertilizer suggested above should be applied in the spring and at the same time broadcast along the rows Nitrate of Soda at the rate of 200 pounds per acre. If the plants lose color in spots late in the season, work into the soil about the vine an ounce or so of Nitrate, but this must not be done later than midsummer.

Profitable Fertilization of Grapes.

Summary of Experiments by the Director of Darmstadt Agricultural Experiment Station, Darmstadt, Germany.

Systematic fertilizer experiments with grapes have been conducted in this country so rarely that we must seek information in this line from foreign experimenters. The experiment detailed below was conducted by the Darmstadt Agricultural Experiment Station, Darmstadt, Germany. The vines were grown singly in pots. The fertilizer application in the two pots illustrated herewith were at the rate of 3.3 ounces of Nitrate of Soda, .6 of an ounce muriate of potash and 2 ounces acid phosphate per vine. At the rate of 907 vines per acre (vines 6 by 8 feet) this application is the equivalent of 189 pounds Nitrate of Soda, 113 pounds acid phosphate and 34 pounds muriate of potash per acre. The illustrations (pages 192–193) show the growth of vine and also the production of fruit from the two pots, and the excellent effect of Nitrate of Soda were unmistakably shown. The actual yields of fruit were:

	Per Acre.
Potash and acid phosphate without Nitrate of Soda...	1,024 lbs.
Potash and acid phosphate with Nitrate of Soda......	4,929 "

A remarkable point in this experiment was data to show the growth of leaf and wood for each 100 pounds of grapes, as follows:

With Nitrate, for 100 lbs. grapes..........	47 lbs.	13 lbs.
Without Nitrate, for 100 lbs. grapes.......	119 "	34 "

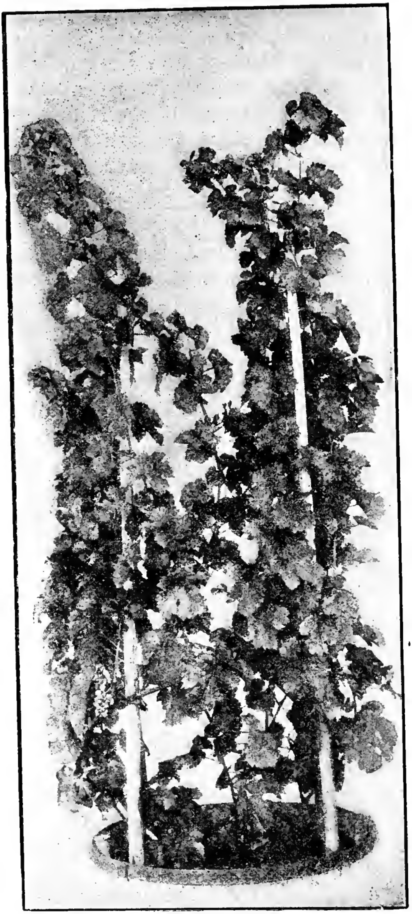
The evidence tends to confirm the belief that insufficient or improperly balanced fertilizers produce wood and leaf growth often at the expense of the fruit;

that is, the merchantable portion of the crop. In fertilizing grapes the phosphate and potash should be applied early in the spring, before the vines begin to grow; Nitrate of Soda should be applied just at the time the vines commence growth in the spring. A better plan perhaps is to apply the Nitrate in two doses, one when the vines start growth in the spring, the second some time three weeks later.

Nursery Stock.

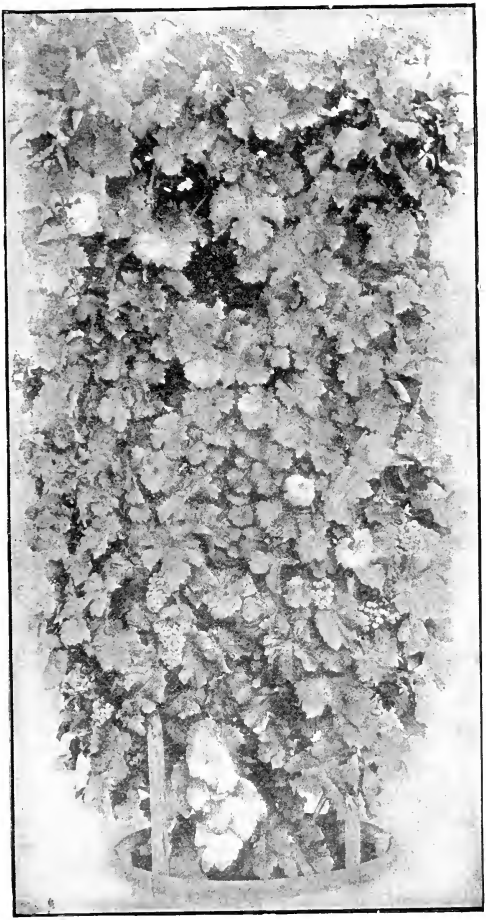
The soil should be moderately light loam, somewhat deep and thoroughly worked. It is an advantage if the soil has previously been in corn, or some other clean cultivation crop. Nursery stock should not be planted on turned-under clover stubble. A soil rich in ammoniates produces an overgrowth of wood, which fails to mature. This is caused by continued supplies of natural Nitrate up to the time of frost, and as a consequence new sap wood is continually being formed only to be killed back in winter. The ammonia in all low grade fertilizers is slowly Nitrated by the action of certain soil organisms, which continue at work so long as there are any ammoniates to work upon, or the soil not frozen. All through the season of growth, more or less Nitrated ammonia is being supplied, which acts to prevent the complete ripening of the summer's growth.

This is a marked evil in growing nursery stock. The work is not matured and is badly killed back by frost, causing serious disfigurement; also the young trees become too slender and suffer more in transplanting. Apply along the rows a fertilizer consisting of 200 pounds of acid phosphate and 200 pounds of sulphate of potash, at the rate of 400 pounds per acre, and work well into the soil. When the young trees are in full leaf, apply in the same manner 300 to 400 pounds of Nitrate of Soda to the acre; and, four weeks later, repeat the Nitrate application, using 150 to 200 pounds. This will ensure a rapid growth early in the season with ample time for thorough maturing before cold weather.



Fertilizer per Vine, Omitting Nitrate Nitrogen.

0.6 oz. Muriate or Sulphate of Potash per vine, or 34 lbs. per acre.
2 oz. Acid Phosphate per vine, or 113 lbs. per acre.



Fertilizer per Vine, With Nitrate Nitrogen.

0.6 oz. Muriate or Sulphate of Potash per vine, or 34 lbs. per acre.
2 oz. Acid Phosphate per vine, or 113 lbs. per acre.
3.3 oz. Nitrate of Soda per vine, or 189 lbs. per acre.

The Nitrate of Soda supplies only Nitrated ammonia, which is immediately available for the uses of the plant. Nursery stock must be constantly watched for evidences of disease, and prompt action taken when such are discovered.

Orange Groves.

An orange that weighs a pound would sell in New York for a dime. When it takes six to weigh a pound they are worthless.

Satisfactory results have been obtained in Florida by fertilizing during the cold season. About two months before the period of growth begins, apply for each full-grown tree a mixture of 7 pounds of high-grade superphosphate and 7 pounds of sulphate of potash, by working it into the soil; after which one pound of Nitrate of Soda may be sown on the surface. In order to accomplish this application economically it is well to mix the Nitrate with two or three times the quantity of fine, dry soil before applying. The working of the soil must not be so deep or thorough as to start the growth of the tree. An excess of Nitrate is to be avoided, but the amount mentioned is not too much. All other ammoniates on the market must be converted into Nitrate by weathering and the action of the soil bacteria before they can possibly be available for plant food. Nitrate of Soda is a pre-digested ammoniate. With sulphate of ammonia there is danger of loss, as it must be converted into Nitrate before it is available as food, and during this comparatively long process it may all be lost by rains and leaching.

Dried blood, cotton-seed meal and all other ammoniates, if used in such quantities as to afford an adequate supply of Nitrate, may cause die-back. No disease results from the proper use of Nitrate of Soda. Besides the possible losses indicated, when other ammoniates are used, there is an actual loss of Nitrogen during the process of Nitration, and all ammoniates must undergo Nitration—must be Nitrated before living trees or plants will feed on them.

From six weeks to two months after the above applications Nitrate may be used again as above indicated. If desirable, two or three months later a further application of one and a half pounds of Nitrate of Soda and potash may be made. In the case of your particular soil, it may well be that it is sufficiently rich in potash, and therefore, may not require a large application of it. In any event, the grower must be governed by the condition of his grove and the general character of soil and climate in his particular locality.

The early decay of orchards as well as failure to set fruit buds, is largely a matter of lack of plant food. Orchards should have Nitrate, applied early in the season, as late supplies of Nitrogen are liable to cause a heavy setting of leaf buds at the expense of next year's fruit. The ordinary ammoniates are not satisfactory for orchard work, as they continue to supply available ammonia all through the season; not enough in the early part of the year to properly set the fruit, hence severe dropping; too much late in the year when none is needed and which causes the formation of leaf rather than fruit buds. The soil between the trees should be regularly tilled, much as in corn growing. That it is not generally done is no argument against the value of such cultivation methods.

Of General Interest.

Average Annual Rainfall in the United States.

Place.	Inches.	Place.	Inches.
Neah Bay, Wash	123	Hanover, New Hampshire	40
Sitka, Alaska	83	Ft. Vancouver	38
Ft. Haskins, Oregon	66	Cleveland, Ohio	37
Mt. Vernon, Alabama	66	Pittsburgh, Pennsylvania	37
Baton Rouge, Louisiana	60	Washington, D. C	37
Meadow Valley, California	57	White Sulphur Springs, Va.	37
Ft. Towson, Oklahoma	57	Ft. Gibson, Oklahoma	36
Ft. Meyers, Florida	56	Key West, Florida	36
Washington, Arkansas	54	Peoria, Illinois	35
Huntsville, Alabama	54	Burlington Vermont	34
Natchez, Mississippi	53	Buffalo, New York	33
New Orleans, Louisiana	51	Ft. Brown, Texas	33
Savannah, Georgia	48	Ft. Leavenworth, Kansas	31
Springdale, Kentucky	48	Detroit, Michigan	30
Fortress Monroe, Virginia	47	Milwaukee, Wisconsin	30
Memphis, Tennessee	45	Penn Yann, New York	28
Newark, New Jersey	44	Ft. Kearney	25
Boston, Massachusetts	44	Ft. Snelling, Minnesota	25
Brunswick, Maine	44	Salt Lake City, Utah	23
Cincinnati, Ohio	44	Mackinac, Michigan	23
New Haven, Connecticut	44	San Francisco, California	21
Philadelphia, Pennsylvania	44	Dallas, Oregon	21
New York City, N. Y	43	Sacramento, California	21
Charleston, South Carolina	43	Ft. Massachusetts, Colorado	17
Gaston, North Carolina	43	Ft. Marcy, New Mexico	16
Richmond, Indiana	43	Ft. Randall, Dakota	16
Marietta, Ohio	43	Ft. Defiance, Arizona	14
St. Louis, Missouri	43	Ft. Craig, New Mexico	11
Muscatine, Iowa	42	San Diego, California	9
Baltimore, Maryland	41	Ft. Colville, Washington	9
New Bedford, Massachusetts	41	Ft. Bliss, Texas	9
Providence, Rhode Island	41	Ft. Bridger, Utah	6
Ft. Smith, Arkansas	40	Ft. Garland, Colorado	6

Number of Years Seeds Retain Their Vitality.

Vegetables.	Years.	Vegetables.	Years.
Cucumber	8 to 10	Endive	5 to 6
Melon	8 to 10	Pea	5 to 6
Pumpkin	8 to 10	Radish	4 to 5
Squash	8 to 10	Beets	3 to 4
Broccoli	5 to 6	Cress	3 to 4
Cauliflower	5 to 6	Lettuce	3 to 4
Artichoke	5 to 6	Mustard	3 to 4

Okra	3 to 4	Parsley	2 to 3
Rhubarb	3 to 4	Parsnip	2 to 3
Spinach	3 to 4	Pepper	2 to 3
Turnip	3 to 6	Tomato	2 to 3
Asparagus	2 to 3	Egg-Plant	1 to 2
Beans	2 to 3		
Carrots	2 to 3	Herbs.	
Celery	2 to 3	Anise	3 to 4
Corn (on cob)	2 to 3	Caraway	2
Leek	2 to 3	Summer Savory	1 to 2
Onion	2 to 3	Sage	2 to 3

How Deep in the Ground to Plant Corn.

The following is the result of an experiment with Indian Corn. That which was planted at a depth of

1 inch came up in	8½ days.
1½ inch, came up in	9½ days.
2 inches, came up in	10 days.
2½ inches, came up in	11½ days.
3 inches, came up in	12 days.
3½ inches, came up in	13 days.
4 inches, came up in	13½ days.

The more shallow the seed was covered with earth, the more rapidly the sprout made its appearance, and the stronger afterwards was the stalk. The deeper the seed lay, the longer it remained before it came to the surface. Four inches was too deep for the maize, and must, therefore, be too deep for smaller kernels.

Amount of Barbed Wire Required for Fences.

Estimated number of pounds of Barbed Wire required to fence space for distances mentioned, with one, two or three lines of wire, based upon each pound of wire, measuring one rod (16½ feet).

	1 line	2 lines	3 lines
1 square acre	50⅔ lbs.	101⅓ lbs.	152 lbs.
1 side of a square acre	12⅔ lbs.	25⅓ lbs.	38 lbs.
1 square half-acre	36 lbs.	72 lbs.	108 lbs.
1 square mile	1,280 lbs.	2,560 lbs.	3,840 lbs.
1 side of a square mile	230 lbs.	460 lbs.	690 lbs.
1 rod in length	1 lb.	2 lbs.	3 lbs.
100 rods in length	100 lbs.	200 lbs.	300 lbs.
100 feet in length	6 1/16 lbs.	12⅛ lbs.	18 3/16 lbs.

How Grain will Shrink.

Farmers rarely gain by holding on to their grain after it is fit for market, when the shrinkage is taken into account. Wheat, from the time it is threshed, will shrink two quarts to the bushel or six per cent. in six months, in the most favorable circumstances. Hence, it follows that ninety-four cents a bushel for wheat when first threshed in August, is as good, taking into account the shrinkage alone, as one dollar in the following February.

Corn shrinks much more from the time it is first husked. One hundred bushels of ears, as they come from the field in November, will be reduced to not far from eighty. So that forty cents a bushel for corn in the ear, as it comes from the field, is as good as fifty in March, shrinkage only being taken into account.

In the case of potatoes—taking those that rot and are otherwise lost—together with the shrinkage, there is but little doubt that between October and June, the loss to the owner who holds them is not less than thirty-three per cent.

This estimate is taken on the basis of interest at 7 per cent., and takes no account of loss by vermin.

One hundred pounds of Indian meal is equal to 76 pounds of wheat, 83 of oats, 90 of rye, 111 of barley, 333 of corn stalks.

Length of Navigation of the Mississippi River.

The length of navigation of the Mississippi River itself for ordinary large steamboats is about 2,161 miles, but small steamers can ascend about 650 miles further. The following are its principal navigable tributaries, with the miles open to navigation:

	Miles.		Miles.
Minnesota	295	Wisconsin	160
Chippewa	90	Rock	64
Iowa	80	Illinois	350
Missouri	2,900	Yellowstone	474
Big Horn	50	Ohio	950
Allegheny	325	Monongahela	110
Muskingum	94	Kanawha	94
Kentucky	105	Green	200
Wabash	365	Cumberland	600
Tennessee	270	Clinch	50
Osage	302	St. Francis	180
White	779	Black	147
Little White	48	Arkansas	884
Big Hatchie	75	Issaquena	161
Sunflower	271	Yazoo	228
Tallahatchie	175	Big Black	35
Red	986	Cane	54
Cypress	44	Ouachita	384
Black	61	Bœuf	55
Bartholomew	100	Tensas	112
Macon	60	Teche	91
Atchafalaya	218	D'Arbonne	50
Lafourche	168		

The other ten navigable tributaries have less than fifty miles each of navigation. The total miles of navigation of these fifty-five streams is about 16,500 miles, or about two-thirds the distance around the world. The Mississippi and its tributaries may be estimated to possess 15,550 miles navigable to steamboats, and 20,221 miles navigable to barges.

Carrying Capacity of a Freight Car.

This Table is for Ten Ton Cars.

Whiskey	60 barrels	Lumber	6,000 feet
Salt	70 barrels	Barley	300 bushels
Lime	70 barrels	Wheat	340 bushels
Flour	90 barrels	Flax Seed	360 bushels
Eggs	130 to 160 barrels	Apples	370 bushels
Flour	200 sacks	Corn	400 bushels
Wood	6 cords	Potatoes	430 bushels
Cattle	18 to 20 head	Oats	680 bushels
Hogs	50 to 60 head	Bran	1,000 bushels
Sheep	80 to 100 head	Butter	20,000 pounds

How to Measure Corn in Crib, Hay in Mow, etc.

This rule will apply to a crib of any size or kind. Two cubic feet of good, sound, dry corn in the ear will make a bushel of shelled corn. To get, then, the quantity of shelled corn in a crib of corn in the ear, measure the length, breadth and height of the crib, inside of the rail; multiply the length by the breadth and the product by the height; then divide the product by two, and you have the number of bushels of shelled corn in the crib.

To find the number of bushels of apples, potatoes, etc., in a bin, multiply the length, breadth and thickness together, and this product by 8, and point off one figure in the product for decimals.

To find the amount of hay in a mow, allow 512 cubic feet for a ton, and it will come out very generally correct.

Business Rules for Farmers.

The way to get credit is to be punctual in paying your bills. The way to preserve it is not to use it much. Settle often; have short accounts.

Trust no man's appearances—they are deceptive—perhaps assumed, for the purpose of obtaining credit. Beware of gaudy exterior. Rogues usually dress well. The rich are plain men. Trust him, if any, who carries but little on his back. Never trust him who flies into a passion on being dunned; make him pay quickly, if there be any virtue in the law.

Be well satisfied before you give a credit that those to whom you give it are men to be trusted.

Sell your goods at a small advance, and never misrepresent them, for those whom you once deceive will beware of you the second time.

Deal uprightly with all men, and they will repose confidence in you, and soon become your permanent customers.

Beware of him who is an office seeker. Men do not usually want an office when they have anything to do. A man's affairs are rather low when he seeks office for support.

Trust no stranger. Your goods are better than doubtful charges. What is character worth, if you make it cheap by crediting everybody?

Agree beforehand with every man about to do a job, and, if large, put in into writing. If any decline this, quit, or be cheated. Though you want a job ever so much, make all sure at the outset, and in case at all doubtful, make sure of a guarantee. Be not afraid to ask it; the best test of responsibility; for, if offence be taken, you have escaped a loss.

Business Laws in Brief.

Ignorance of law excuses none.

It is a fraud to conceal a fraud.

The law compels no one to do impossibilities.

An agreement without consideration is void.

Signatures made with lead-pencil are good in law.

A receipt for money paid is not legally conclusive.

The acts of one partner bind all the others.

Contracts made on Sunday cannot be enforced.

A contract made with a minor is invalid.

A contract made with a lunatic is void.

Contracts for advertising in Sunday newspapers are invalid.

Each individual in a partnership is responsible for the whole amount of the debts of a firm.

Principals are responsible for the acts of their agents.

Agents are responsible to their principals for errors.

A note given by a minor is void.

It is not legally necessary to say on a note "for value received."

A note drawn on Sunday is void.

A note obtained by fraud, or from a person in a state of intoxication, cannot be collected.

If a note be lost or stolen, it does not release the maker; he must pay.

The indorser of a note is exempt from liability if not served with notice of its dishonor within twenty-four hours of its nonpayment.

How to Treat Sunstroke.

Take the patient at once to a cool and shady place, but don't carry him far to a house or hospital. Loosen the clothes thoroughly about his neck and waist Lay him down with the head a little raised. Apply wet cloths to the head, and mustard or turpentine to the calves of the legs and the soles of the feet. Give a little weak whiskey and water if he can swallow. Mean-while, let some one go for the doctor. You cannot do more without his advice.

Sunstroke is a sudden prostration due to long exposure to great heat, especially when much fatigued or exhausted. It commonly happens from undue exposure to the sun's rays in summer. It begins with pain in the head, or dizziness, quickly followed by loss of consciousness and complete prostration.

Time Required for Digesting Food.

Food.	How Cooked.	H. M.
Apples, sour, hard	Raw	2.50
Apples, sweet, mellow	Raw	1.30
Bass, striped	Broiled	3.00
Beans, pod	Boiled	2.30
Beans and green corn	Boiled	3.45
Beef	Fried	4.00
Beefsteak	Broiled	3.00
Beef, fresh, lean, dry	Roasted	3.30
Beef, fresh, lean, rare	Roasted	3.00
Beets	Boiled	3.45
Bread, corn	Baked	3.15
Bread, wheat, fresh	Baked	1.30
Cabbage	Raw	2.30
Cabbage, with vinegar	Raw	2.00
Cabbage	Boiled	4.30
Carrot	Boiled	3.13
Catfish	Fried	3.30
Cheese, old, strong	Raw	3.30
Chicken, full grown	Fricasseed	2.45
Codfish, cured dry	Boiled	2.00
Custard	Baked	2.45
Duck, tame	Roasted	4.00
Duck, wild	Roasted	4.30
Eggs, fresh	Raw	2.00
Eggs, fresh	Scrambled	1.30
Eggs, fresh	Roasted	2.15
Eggs, fresh	Soft boiled	3.00
Eggs, fresh	Hard boiled	3.30
Eggs, fresh	Fried	3.30
Fowls, domestic	Roasted	4.00
Hashed meat and vegetables	Warmed	2.30
Lamb, fresh	Broiled	2.30
Milk	Boiled	2.00
Milk	Raw	2.15
Mutton, fresh	Broiled	3.00
Oysters, fresh	Raw	2.55
Oysters, fresh	Roasted	3.15
Oysters, fresh	Stewed	3.30
Parsnips	Boiled	2.30

Pork, steak	Broiled	3.15
Pork, fat and lean	Roasted	5.15
Pork, recently salted	Stewed	3.00
Pork, recently salted	Fried	4.15
Potatoes, Irish	Baked	2.30
Potatoes, Irish	Boiled	3.30
Salmon, salted	Boiled	4.00
Sausages, fresh	Broiled	3.20
Soup, bean	Boiled	3.00
Soup, chicken	Boiled	3.00
Soup, mutton	Boiled	3.30
Soup, beef, vegetable	Boiled	4.00
Trout, salmon, fresh	Boiled	1.30
Turkey, domesticated	Roasted	2.30
Veal, fresh	Boiled	4.00
Veal, fresh	Fried	4.30

How to Rent a Farm.

In the rental of property, the greater risk is always on the landlord's side. He is putting his property into the possession and care of another, and that other is not infrequently a person of doubtful utility. These rules and cautions may well be observed:

1. Trust to no verbal lease. Let it be in writing, signed and sealed. Its stipulations then become commands and can be enforced. Let it be signed in duplicate, so that each party may have an original.

2. Insert such covenants as to repairs, manner of use and in restraint of waste, as the circumstances call for. As to particular stipulations, examine leases drawn by those who have had long experience in renting farms, and adopt such as meet your case.

3. There should be covenants against assigning and underletting.

4. If the tenant is of doubtful responsibility, make the rent payable in installments. A covenant that the crops shall remain the lessor's till the lessee's contracts with him have been fulfilled, is valid against the lessee's creditors. In the ordinary case of renting farms on shares, the courts will treat the crops as the joint property of landlord and tenant, and thus protect the former's rights.

5 Every lease shou'd contain stipulations for forfeiture and re-entry in case of non-payment or breach of any covenants.

6 To prevent a tenant's committing waste, the courts will grant an injunction.

7. Above all, be careful in selecting your tenant. There is more in the man than there is in the bond.

Facts for the Weatherwise.

If the full moon rises clear, expect fine weather.

A large ring around the moon and low clouds indicate rain in twenty-four hours; a small ring and high clouds, rain in several days.

The larger the halo about the moon the nearer the rain clouds, and the sooner the rain may be expected.

When the moon is darkest near the horizon, expect rain.

If the full moon rises pale, expect rain.

A red moon indicates wind.

If the moon is seen between the scud and broken cloud during a gale, it is expected to send away the bad weather.

In the old of the moon a cloudy morning bodes a fair afternoon.

If there be a general mist before sunrise near the full of the moon, the weather will be fine for some days.

Farmers' Barometers.

If chickweed and scarlet pimpernel expand their tiny petals, rain need not be expected for a few hours, says a writer.

Bees work with redoubled energy before a rain.

If flies are unusually persistent either in the house or around the stock, there is rain in the air.

The cricket sings at the approach of cold weather.

Squirrels store a large supply of nuts, the husks of corn are usually thick, and the buds of deciduous trees have a firmer protecting coat if a severe winter is at hand.

Corn fodder is extremely sensitive to hygrometr'c changes. When dry and crisp, it indicates fair weather; when damp and limp, look out for rain.

A bee was never caught in a shower; therefore when his bees leave their hive in search of honey, the farmer knows that the weather is going to be good.

How to See the Wind.

Few persons know that it is possible actually to see the wind, but it can be done as follows:

Take a polished metal surface of two feet or more, with a straight edge; a large hand-saw will answer the purpose. Choose a windy day for the experiment, whether hot or cold, clear or cloudy; only let it not be in murky, rainy weather.

Hold your metallic surface at right angles to the direction of the wind—*i. e.*, if the wind is north hold your surface east and west, but instead of holding it vertical incline it about forty-two degrees to the horizon, so that the wind, striking, glances and flows over the edge as the water flows over a dam. Now sight carefully along the edge some minutes at a sharply defined object, and you will see the wind pouring over the edge in graceful curves. Make your observations carefully and you will hardly ever fail in the experiment. The results are better if the sun is obscured.

Philosophical Facts.

The greatest height at which visible clouds ever exist does not exceed ten miles.

Air is about eight hundred and fifteen times lighter than water.

The pressure of the atmosphere upon every square foot of the earth amounts to two thousand one hundred and sixty pounds. An ordinary sized man, supposing his surface to be fourteen square feet, sustains the enormous pressure of thirty thousand, two hundred and forty pounds.

The barometer falls one-tenth of an inch for every seventy-eight feet of elevation.

The violence of the expansion of water when freezing is sufficient to cleave a globe of copper of such thickness as to require a force of 27,000 pounds to produce the same effect.

During the conversion of ice into water one hundred and forty degrees of heat are absorbed.

Water, when converted into steam, increases in bulk eighteen hundred times.

In one second of time—in one beat of the pendulum of a clock—light travels two hundred thousand miles. Were a cannon ball shot toward the sun, and were it to maintain full speed, it would be twenty years in reaching it—and yet light travels through this space in seven or eight minutes.

Strange as it may appear, a ball of a ton weight and another of the same material of an ounce weight, falling from any height will reach the ground at the same time.

The heat does not increase as we rise above the earth nearer to the sun but decreases rapidly until, beyond the regions of the atmosphere, in void, it is estimated that the cold is about seventy degrees below zero. The line of perpetual frost at the equator is 15,000 feet altitude; 13,000 feet between the tropics; and 9,000 to 4,000 between the latitudes of forty and forty-nine degrees.

At a depth of forty-five feet under ground, the temperature of the earth is uniform throughout the year.

In summer time, the season of ripening moves northward at the rate of about ten miles a day.

The human ear is so extremely sensitive that it can hear a sound that lasts only the twenty-four thousandth part of a second. Deaf persons have sometimes conversed together through rods of wood held between their teeth, or held to their throat or breast.

The ordinary pressure of the atmosphere on the surface of the earth is two thousand one hundred and sixty pounds to each square foot, or fifteen pounds to each square inch; equal to thirty perpendicular inches of mercury, or thirty-four and a half feet of water.

Sound travels at the rate of one thousand one hundred and forty-two feet per second—about thirteen miles in a minute. So that if we hear a clap of thunder half a minute after the flash, we may calculate that the discharge of electricity is six and a half miles off.

Lightning can be seen by reflection at the distance of two hundred miles.

The explosive force of closely confined gunpowder is six and a half tons to the square inch.

How to Preserve Eggs.

To each pailful of water, add two pints of fresh slacked lime and one pint of common salt; mix well. Fill your barrel half full with this fluid, put your eggs down in it any time after June, and they will keep two years, if desired. A solution of silicate of soda, commonly known as water glass, is also used for the same purpose.

Estimating Measures.

A pint of water weighs nearly 1 pound, and is equal to about 27 cubic inches, or a square box 3 inches long, 3 inches wide and 3 inches deep.

A quart of water weighs nearly 2 pounds, and is equal to a square box of about 4 by 4 inches and 3½ inches deep.

A gallon of water weighs from 8 to 10 pounds, according to the size of the gallon, and is equal to a box 6 by 6 inches square and 6, 7 or 7½ inches deep.

A peck is equal to a box 8 by 8 inches square and 8 inches deep.

A bushel almost fills a box 12 by 12 inches square and 15 inches deep. In exact figures, a bushel contains 2150.42 cubic inches.

A cubic foot of water weighs nearly 64 pounds (more correctly 62½ pounds), and contains from 7 to 8 gallons, according to the kind of gallons used.

A barrel of water almost fills a box 2 by 2 feet square and 1½ feet deep, or 6 cubic feet.

Petroleum barrels contain 40 gallons, or nearly 5 cubic feet.

Square Measure.

144 sq. in.—1 sq. foot	160 sq. rods—1 acre
9 sq. feet—1 sq. yard	43,560 sq. ft.—1 acre
30¼ sq. yards—1 sq. rod	640 acres—1 sq. mile

2.47 acre—1 Hectare.

Number of Brick Required to Construct any Building.

(Reckoning 7 Brick to Each Superficial Foot.)

Superficial Feet of Wall.	Number of Bricks to Thickness of					
	4 inch.	8 inch.	12 inch.	16 inch.	20 inch.	24 inch.
1..........	7	15	23	30	38	45
2..........	15	30	45	60	75	90
3..........	23	45	68	90	113	135
4..........	30	60	90	120	150	180
5..........	38	75	113	150	188	225
6..........	45	90	135	180	225	270
7..........	53	105	158	210	263	315
8..........	60	120	180	240	300	360
9..........	68	135	203	270	338	405
10..........	75	150	225	300	375	450
20..........	150	300	450	600	750	900
30..........	225	450	675	900	1,125	1,350
40..........	300	600	900	1,200	1,500	1,800
50..........	375	750	1,125	1,500	1,875	2,250
60..........	450	900	1,350	1,800	2,250	2,700
70..........	525	1,050	1,575	2,100	2,625	3,150
80..........	600	1,200	1,800	2,400	3,000	3,600
90..........	675	1,350	2,025	2,700	3,375	4,050
100..........	750	1,500	2,250	3,000	3,750	4,500
200..........	1,500	3,000	4,500	6,000	7,500	9,000
300..........	2,250	4,500	6,750	9,000	11,250	13,500
400..........	3,000	6,000	9,000	12,000	15,000	18,000
500..........	3,750	7,500	11,250	15,000	18,750	22,500
600..........	4,500	9,000	13,500	18,000	22,500	27,000
700..........	5,250	10,500	15,750	21,000	26,250	31,500
800..........	6,000	12,000	18,000	24,000	30,000	36,000
900..........	6,750	13,500	20,250	27,000	33,750	40,500
1000..........	7,500	15,000	22,500	30,000	37,500	45,000

Facts for Builders.

One thousand shingles, laid 4 inches to the weather, will cover 100 square feet of surface, and 5 pounds of shingle nails will fasten them on.

One-fifth more siding and flooring is needed than the number of square feet of surface to be covered, because of the lap in the siding and matching.

One thousand laths will cover 70 yards of surface, and 11 pounds of lath nails will nail them on. Eight bushels of good lime, 16 bushels of sand, and one bushel of hair, will make enough good mortar to plaster 100 square yards.

A cord of stone, 3 bushels of lime and a cubic yard of sand, will lay 100 cubic feet of wall.

Five courses of brick will lay one foot in height on a chimney; 16 bricks in a course will make a flue 4 inches wide and 12 inches long, and 8 bricks in a course will make a flue 8 inches wide and 16 inches long.

Cement 1 bushel and sand 2 bushels will cover 3½ square yards 1 inch thick, 4½ square yards ¾ inch thick, and 6¾ square yards ½ inch thick. One bushel cement and 1 of sand will cover 2½ square yards 1 inch thick, 3 square yards ¾ inch thick, and 4¼ square yards ½ inch thick.

Weight of a Cubic Foot of Earth, Stone, Metal, Etc.

Article.	Pounds.	Article.	Pounds.
Alcohol	49	Milk	64
Ash wood	53	Maple	47
Bay wood	51	Mortar	110
Brass, gun metal	543	Mud	102
Blood	66	Marble, Vermont	165
Brick, common	102	Mahogany	66
Cork	15	Oak, Canadian	54
Cedar	35	Oak, live, seasoned	67
Copper, cast	547	Oak, white, dry	54
Clay	120	Oil, linseed	59
Coal, Lehigh	56	Pine, yellow	34
Coal, Lackawanna	50	Pine, white	34
Cider	64	Pine, red	37
Chestnut	38	Pine, well seasoned	30
Earth, loose	94	Silver	625¾
Glass, window	165	Steel, plates	487¾
Gold	1,203⅔	Steel, soft	489
Hickory, shell bark	43	Stone, common, about	158
Hay, bale	9	Sand, wet, about	128
Hay, pressed	25	Spruce	31
Honey	90	Tin	455
Iron, cast	450	Tar	63
Iron, plates	481	Vinegar	67
Iron, wrought bars	486	Water, salt	64
Ice	57½	Water, rain	62
Lignum Vitæ wood	83	Willow	36
Logwood	57	Zinc, cast	428
Lead, cast	709		

What a Deed to a Farm in Many States Includes

Every one knows it conveys all the fences standing on the farm, but all might not think it also included the fencing-stuff, posts, rails, etc., which had once been used in the fence, but had been taken down and piled up for future use again in the same place. But new fencing material, just bought, and never attached to the soil, would not pass. So piles of hop poles stored away, if once used on the land and intended to be again so used, have been considered a part of it, but loose boards or scaffold poles merely laid across the beams of the barn, and never fastened to it, would not be, and the seller of the farm might take them away. Standing trees, of course, also pass as part of the land; so do trees blown down or cut down, and still left in the woods where they fell, but not if cut, and corded up for sale; the wood has then become personal property.

If there be any manure in the barnyard, or in the compost heap on the field, ready for immediate use, the buyer ordinarily, in the absence of any contrary agreement, takes that also as belonging to the farm, though it might not be so, if the owner had previously sold it to some other party and had collected it together in a heap by itself, for such an act might be a technical severance from the soil, and so convert real into personal estate; and even a lessee of a farm could not take away the manure made on the place while he was in occupation. Growing crops also pass by the deed of a farm, unless they are expressly reserved; and when it is not intended to convey those, it should be so stated in the deed itself; a mere oral agreement to that effect would not be, in most States, valid in law. Another mode is to stipulate that possession is not to be given until some future day, in which case the crops or manures may be removed before that time.

As to the buildings on the farm, though generally mentioned in the deed, it is not absolutely necessary they should be. A deed of land ordinarily carries all the buildings on it, belonging to the grantor, whether mentioned or not; and this rule includes the lumber and timber of any old building which has been taken down, or blown down, and packed away for future use on farm.

Relative Value of Different Foods for Stock.

One hundred pounds of good hay for stock are equal to:

Articles.	Pounds.	Articles.	Pounds.
Beets, white silesia	669	Lucern	89
Turnips	469	Clover, red, dry	88
Rye--Straw	429	Buckwheat	78½
Clover, Red, Green	373	Corn	62½
Carrots	371	Oats	59
Mangolds	368½	Barley	58
Potatoes, kept in pit	350	Rye	53½
Oat-Straw	347	Wheat	44½
Potatoes	360	Oil-Cake, linseed	43
Carrot leaves (tops)	135	Peas, dry	37½
Hay, English	100	Beans	28

Hints for Farmers.

Vincent's Remedies for farm animals have been used with considerable success for several years, and they are recommended here as being worthy of trial.

First for Horses. When horses have chills, or have taken cold, or have colic, 15-20 drops of Aconite in a teacup of warm water will start perspiration, and if the horses are kept heavily blanketed, if the ailments are not more than ordinary, they will come out of them in good condition.

For Cattle. When cows get chilled, and if for any reason after dropping calves, the cows appear to shake, 15 drops of Aconite in a teacup of warm water will start perspiration, and if the cows are kept well blanketed, they will come out of the trouble without further treatment, unless the ailments are more than usual.

For Calves. A disease which has killed many fine young animals, even under the best conditions, is known as "scours." Vincent's cure in this case is a teaspoonful of Essence of Peppermint in half a teacup of warm water. This is to be administered after feeding night and morning, and is almost a certain cure, having saved the lives of many valuable calves.

For Sheep. A disease known as "stretches," caused by some stoppage in the bowels, can be frequently remedied by raising the sheep by its hind legs and holding it in that position for some minutes. In nine cases out of ten, a permanent cure is effected. This is worth remembering on account of many sheep having died from this cause.

Weights and Measures for Cooks, Etc.

1 pound of wheat flour is equal to....................	1 quart
1 pound and 2 ounces of indian meal make.............	1 quart
1 pound of soft butter is equal to......................	1 quart
1 pound and 2 ounces of best brown sugar make.........	1 quart
1 pound and 1 ounce of powdered white sugar make.....	1 quart
1 pound of broken loaf sugar is equal to...............	1 quart
4 large tablespoonfuls make..........................	½ gill
1 common-sized tumbler holds........................	½ pint
1 common-sized wine-glass is equal to.................	½ gill
1 tea-cup holds..	1 gill
1 large wine-glass holds............................	2 ounces
1 tablespoonful is equal to..........................	½ ounce

Capacity of Cisterns for Each 10 Inches in Depth.

25	feet in diameter holds.......................	3059 gallons
20	feet in diameter holds.......................	1958 gallons
15	feet in diameter holds.......................	1101 gallons

14	feet in diameter holds	959 gallons
13	feet in diameter holds	827 gallons
12	feet in diameter holds	705 gallons
11	feet in diameter holds	592 gallons
10	feet in diameter holds	489 gallons
9	feet in diameter holds	396 gallons
8	feet in diameter holds	313 gallons
7	feet in diameter holds	239 gallons
6½	feet in diameter holds	206 gallons
6	feet in diameter holds	176 gallons
5	feet in diameter holds	122 gallons
4½	feet in diameter holds	99 gallons
4	feet in diameter holds	78 gallons
3	feet in diameter holds	44 gallons
2½	feet in diameter holds	30 gallons
2	feet in diameter holds	19 gallons

Surveyor's Measure.

7.92 inches 1 link, 25 links 1 rod, 4 rods 1 chain, 10 square chains or 160 square rods 1 acre, 640 acres 1 square mile.

Strength of Ice of Different Thickness.

Two inches thick—will support a man.

Four inches thick—will support a man on horseback.

Five inches thick—will support an eighty-pound cannon.

Eight inches thick—will support a battery of artillery, with carriages and horses.

Ten inches thick—will support an army; an innumerable multitude.

Amount of Oil in Seeds.

Kinds of Seed.	Per Cent. Oil.	Kinds of Seed.	Per Cent. Oil
Rapeseed	55	Oats	6½
Sweet almond	47	Clover hay	5
Turnipseed	45	Wheat bran	4
White mustard	37	Oat straw	4
Bitter almond	37	Meadow hay	3½
Hempseed	19	Wheat straw	3
Linseed	17	Wheat flour	3
Indian corn	7	Barley	2½

To Revive Ferns.

Nitrate of Soda dissolved in water should be given to ferns that are small or weak, one-quarter of an ounce of Nitrate to a gallon of water. One-half an ounce of Nitrate to a gallon of water should be used on plants that are large and vigorous. Soot and salt are also good to use occasionally.

How to Kill Poison Ivy.

Spraying with arsenate of soda (one pound to twenty gallons of water) will kill all vegetation. One application, if the plants are young and tender, will do this. In the middle of summer, however, they should be cut down first, and more than one application given.

To Find the Number of Plants to the Acre.

Divide the number of square feet in an acre, which is 43,560 by the multiplied distance the plants are set each way. For instance: Suppose the plants are set two feet apart and the rows are four feet apart. Four times two are eight; dividing 43,560 by eight we have 5,445, the number of plants to the acre when set 2 feet by 4 feet. If set 5 by 1, there are 8,712 plants to the acre, etc.

Results of Saving Small Amounts of Money.

The following shows how easy it is to accumulate a fortune, provided proper steps are taken. The table shows what would be the result at the end of fifty years by saving a certain amount each day and putting it at interest at the rate of six per cent.:

Daily Savings.	The Result.	Daily Savings.	The Result.
One cent	$ 950	Sixty cents	$57,024
Ten cents	9,504	Seventy cents	66,528
Twenty cents	19,006	Eighty cents	76,032
Thirty cents	28,512	Ninety cents	85,537
Forty cents	38,015	One dollar	95,041
Fifty cents	47,520	Five dollars	465,208

Nearly every person wastes enough in twenty or thirty years, which, if saved and carefully invested, would make a family quite independent; but the principle of small savings has been lost sight of in the general desire to become wealthy.

Savings Bank Compound Interest Table.

Showing the amount of $1.00, from one year to fifteen years, with compound interest added semi-annually, at different rates:

	Three Per Cent.	Four Per Cent.	Five Per Cent.
One year	$1.03	$1.04	$1.05
Two years	1.06	1.08	1.10
Three years	1.09	1.12	1.15
Four years	1.12	1.17	1.21
Five years	1.16	1.21	1.28
Six years	1.19	1.26	1.34
Seven years	1.23	1.31	1.41
Eight years	1.26	1.37	1.48
Nine years	1.30	1.42	1.55
Ten years	1.34	1.48	1.63
Eleven years	1.38	1.54	1.72
Twelve years	1.42	1.60	1.80
Thirteen years	1.47	1.67	1.90
Fourteen years	1.51	1.73	1.99
Fifteen years	1.56	1.80	2.09

Time at which Money Doubles at Interest.

Rate.	Simple Interest.	Compound Interest.
Two per cent	50 years	35 years, 1 day
Two and one-half per cent	40 years	28 years, 26 days
Three per cent	33 years, 4 months	23 years, 164 days
Three and one-half per cent	28 years, 208 days	20 years, 54 days
Four per cent	25 years	17 years, 246 days
Four and one-half per cent	22 years, 81 days	15 years, 273 days
Five per cent	20 years	15 years, 75 days
Six per cent	16 years, 8 months	11 years, 327 days

One dollar loaned one hundred years at compound interest at three per cent. would amount to $19.25, at six per cent. to $340.00.

The Cost of Nitrate of Soda, Its Use more Profitable than ever.

The steady upward movement in prices of Nitrate of Soda has been attracting widespread attention, and the uninterrupted gradual rise in prices is warranted, based on solid facts which govern the industry. Labor troubles and the extra cost of production, together with the steady increase in the consumption, have been and are factors in the situation. The increase in the consumption in this country for several years has been striking. Labor troubles in the Nitrate regions following the great earthquake, as the laborers wended their way to Valparaiso and other sections of the country where better wages were paid them, caused considerable irregularity of shipments, and vessels experienced long delays, owing to the scarcity of labor to move the goods.

The tremendous demand for agricultural purposes, however, has really caused the rise in price. The consumption all over the world for agricultural purposes has expanded at a very great rate lately, and perhaps more particularly in this country in the cotton belt than anywhere else. This great demand has grown very rapidly, hence the effect on prices. Production is likely to expand so as to fully meet the fresh demand as rapidly as the supply of labor can be provided for on the West coast of Chile. The earthquake was followed by a wave of rebuilding activity which made labor very scarce and high.

Looking at the prices current, taking the price for all Nitrogenous fertilizers, it will be noted that they have likewise risen. Many observers of the (Nitrogen) ammoniate market in recent years have asserted that there are not enough ammoniates annually produced to meet the consumption requirements, and the tendency on the part of fertilizer manufacturers is to make lower grade goods; a policy which seems to have invariably a disastrous effect on those who follow it.

It is proper to observe also that all the Nitrogen in Nitrate of Soda is available. In the other ammoniates generally quoted the Nitrogen is, of course, not completely available from an agricultural standpoint even though some may be soluble in water. Nitrate does not leave an acid residue in the soil, but, on the contrary, it leaves a sweet alkali residue, of great benefit to most soils.

A further point of interest is the very satisfactory increase in the prices of agricultural commodities whereby farmers are getting a very handsome return on their produce. It would seem, therefore, that on the whole Nitrate of Soda is still the cheapest ammoniate on the market, and it is to be expected that its intelligent use will yield more profit than ever.

Nitrate always pays handsomely on hay, and one hundred pounds per acre alone is a very effective application. Even at the present prices for Nitrate, one hundred pounds without the use of any other fertilizer, will produce an increased yield of more than half a ton of barn-cured hay. The use of Nitrate on this crop promises to be very remunerative.

POINTS FOR CONSIDERATION AS TO PRICES OF FARM PRODUCTS AND NITRATE PRICES.

From the farmer's point of view, a reduction in cotton and produce prices is to be deplored, but the point to be considered is whether abstention from the use of Nitrate is a wise way of meeting the situation. The utility of a fertilizer obviously depends upon its productivity, and as its productivity is not affected by its price, an increase in the latter justifies abandonment of the fertilizer only when its productivity ceases to be profitable. The profit to be reasonably expected from the use of fertilizer, although somewhat less than when it was cheaper, is not so materially interfered with by any rise in price of Nitrate as to economically justify any substantial reduction in its consumption.

SUMMARY OF INCREASED YIELDS.

From an Application of 100 Pounds per Acre of Nitrate of Soda.

It should be pointed out that in the recorded experiments with Nitrate of Soda on money crops heretofore published in Experiment Station reports and bulletins, farm products were much lower in price. The prices of agricultural products have risen to a high water mark, and in certain cases the advance has been to extreme figures, and all farm commodities are now higher than they have been for some years. Our statements heretofore published, showing the profit resulting from the crop increases due to the use of Nitrate of Soda, if rearranged on a basis of present values for crops, would show more profit than before. It should also be remarked that the prices of other ammoniates have risen higher than Nitrate of Soda, and it is, as heretofore, the cheapest of all ammoniates in the market.

Rise in Price of Farm Products.

Margin of Profit Greater.

Other Ammoniates Higher than Nitrate.

Probable Stability of Farm Values.

Economists of authority tell us that the cost of living is to remain for a considerable time on the high basis now established, so that it is to be expected that the prices of agricultural products will remain at a high level.

Good Results Due to Nitrate.

In this connection your attention is called to many experiments with fertilizers in which Nitrate of Soda is said to have been used in order to produce results to be exploited as due to materials other than this standard money crop producer.

Slight Added Cost per Acre and per Ton of Fertilizer.

Further, one may add, that when Nitrate is used at the rate of 100 pounds per acre, the actual cash increase in Fertilizer cost per acre is very small.

What Nitrate has done for Crops.

Rise in Price of Farm Products.

The highest agricultural authorities have established by careful experimentation that 100 pounds of Nitrate of Soda applied to the crops quoted has produced increased yields as tabulated:

Increased Yield per Acre of Crops receiving Nitrate at the rate of 100 pounds to the Acre over those receiving none.

Wheat	300 pounds of grain.
Oats	400 pounds of grain.
Corn	280 pounds of grain.
Barley	400 pounds of grain.
Potatoes	3,600 pounds of tubers.
Sweet Potatoes	3,900 pounds of tubers.
Hay	1,000 pounds, barn-cured.
Cotton	500 pounds cotton-seed.
Sugar-Beets	4,000 pounds of tubers.
Cabbages	6,100 pounds.
Carrots	7,800 pounds.
Onions	1,800 pounds.
Turnips	37 per cent.
Strawberries	200 quarts.
Asparagus	100 bunches.
Tomatoes	100 baskets.
Celery	30 per cent.
Rye	300 pounds of grain.
Beets	4,000 pounds of tubers.

It should be remembered that plants take up most of their Nitrogen during the early period of their growth.

It is now known that there is not as much danger of it being leached out of the soil by the rains during the growing season as has been generally believed, since the rains seldom reach lower than the bottom of the furrow, and the movement of the soil moisture is up instead of down. Besides, soil moisture is strongly held by good soils by capillary attraction.

Nitrate of Soda looks somewhat like common dairy salt, and horses, cows and sheep, if they can get to it, may eat it to an injurious extent.

The emptied bags, especially in damp weather, have more or less Nitrate adhering to them. After emptying, it is a good plan to soak in water, which will make an excellent liquid manure, say one empty bag to a barrel of water.

If lumpy, the Nitrate should be broken up fine, which is easily done by pounding it on the barn floor with the back of a spade or shovel, or by a hand grinding machine made especially for home mixing, which is now in common use in Europe and is beginning to be used in America.

Nitrate of Soda, unlike other ammoniates and "complete fertilizers," can be mixed with lime or ashes without loss of Nitrogen.

The fallow in modern agriculture, S. RHODIN (*K. Landtbr. Akad. Handl. och Tidskr., 45 (1906), No. 1, 57-72, fig. 1*).—The evidence and views in regard to the value of bare fallow, especially in Swedish agriculture, are briefly discussed. While bare fallow of loose sandy soils is not to be recommended, because the losses of Nitrogenous substances occurring, generally speaking, exceed the gains through Nitration, this is not the case with other types of soils. Here an accumulation of Nitrates takes place through the fallow, which greatly benefits the following grain crop.

Field experiments with cabbages in 1903 and with potatoes in 1904 and 1905 were conducted for the purpose of determining whether inoculation of sandy soils with fallow soil would prove beneficial on account of the large bacterial content of the latter. The systems of fertilization followed are shown below, the different plats receiving as a basal fertilizer 37 per cent. potash salt and Thomas phosphate, at the rate of 225 to 400 lbs. per acre, respectively. The Nitrate of Soda was applied at the rate of 300 lbs. per hectare (121 lbs. per acre) and the inoculated soil at the rate of 6 cubic yards per hectare.

Yields per Acre and Percentage Increase of Crops on Inoculated and Uninoculated Gravelly Soil.

	Cabbages, 1903.		Potatoes, 1904.		Potatoes, 1905.	
	Pounds	*Per cent.*	*Pounds*	*Per cent.*	*Pounds*	*Per cent.*
No fertilizer.........	8,906.88	36	6,791.49	39	9,908.90	62
Potassium phosphate	24,582.99	100	17,368.42	100	15,809.72	100
Potassium phosphate + soil from bean field..............	24,939.27	101	20,819.84	120	20,485.83	130
Potassium phosphate + soil from fallow field..............	33,222.67	135	23,046.56	132	18,370.44	116
Potassium phosphate + Nitrate of Soda.	60,834.00	250	30,172.06	173	23,046.56	145

FARMERS' BULLETIN No. 107.

Prepared in the Office of Experiment Stations, Washington, D. C.

"Under existing conditions farmers are advised to purchase fertilizer materials and to make their own mixtures rather than to purchase mixed or complete special fertilizers. This course is believed to be advisable for two reasons: First, because the 'specials' are not properly compounded, and second, because the needed plant food can be thus procured at lower cost."*

The continuous use of muriate of potash may so far deplete the soil of lime that an occasional application of this material may be required in the case of such use. The sulphate of potash is a safer material to use where a growth of clover is desired than the muriate, and therefore it may often be wise to use the sulphate. The high-grade sulphate should be selected.

These materials should as a rule be mixed just before use, and applied broadcast (after plowing) and harrowed in just before planting the seed. Where Nitrate of Soda is to be used in quantities in excess of 150 pounds per acre, one-half the amount of this salt may be withheld until the crop is 3 or 4 inches high, when it may be evenly scattered near the plants. It is unnecessary to cover this, though it may prove more promptly effective in absence of rain if cultivated in.

The quantities recommended are in most cases moderate. On soils of good physical character it will often prove profitable to use about one and one-half times the amounts given.

Terms Used in Discussing Fertilizers.

NITROGEN may exist in three distinct forms, viz.' as Nitrates, as Nitrogenous organic matter, as ammonia salts.

NITRATES furnish the most readily available forms of Nitrogen. The most common is Nitrate of Soda.

NITRATION, or Nitrification, is the process by which

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*U. S. Department Agriculture Farmers' Bulletins, 65 and 84 (Experiment Station Work, II, page 27; VII, page 5).

soluble Nitrate is formed from the less available and less soluble Nitrogen of sulphate of ammonia, dried blood, cotton-seed meal, tankage, etc. It is due to the action of microscopic organisms, and all nitrogenous fertilizers must undergo this process of Nitration before plants can use them.

PHOSPHORIC ACID, one of the essential fertilizing ingredients, is derived from materials called phosphates. It does not exist alone, but in combination, most commonly as phosphate of lime in the form of bones and Rock phosphate. Phosphoric acid occurs in fertilizers in two forms—available and insoluble phosphoric acid.

SUPERPHOSPHATE.—In natural phosphates the phosphoric acid is insoluble in water and not available to plants, except in the form of a very fine powder. Superphosphate is prepared from these by grinding and treating with sulphuric acid, which makes the phosphoric acid more available. Superphosphates are sometimes called acid-phosphates.

POTASH, as a constituent of fertilizers, exists in a number of forms, but chiefly as sulphate and muriate. The chief sources of potash are the potash salts, muriate of potash, sulphate of potash. Canada wood ashes and cotton-hull ashes are also sources of potash, as is also Nitrate of Potash.

Ammoniates. Nitrogenous Fertilizers.

	Per Cent. Nitrogen.	Lbs. Nitrogen Per Ton.
Nitrate of Soda	15.00	300
Cyanamid	17.00	340
Dried blood	13.00	260
Tankages	4.00 to 12.00	80 to 240
Dry fish scrap	9.00	180
Cotton-seed meal	6.80	136
Barnyard manure	0.05	1
Castor pomace	5.00	100
Bone meal	3.00	60

Phosphates.

	Per Cent. Phosphoric Acid.	Lbs. Phosphoric Acid Per Ton.
Superphosphate	14	280
Ground bone	22	440
Bone tankage	12	240
Barnyard manure	0.32	6.40

Potashes.

	Per Cent. Actual Potash.	Lbs. Potash. Per Ton.
Nitrate of Soda.............	1 to 3	20 to 60
Sulphate of potash..........	48	960
Muriate of potash...........	50	1,000
Waste from gunpowder works	18	360
Maryland marls.............	1.25	25
Castor pomace..............	1.5	30
Tobacco stems..............	7.5	150
Barnyard manure...........	0.43	8.6

Sodas.

	Per Cent. Actual Soda.	Lbs. Soda Per Ton.
Carbonate of Soda...........	50	1,000
Sulphate of Soda............	43	860
Nitrate of Soda..............	35	700

Some Practical Hints Regarding Nitrate.

It is the quickest acting plant food known.

It is immediately available for the use of plants as soon as it goes into solution.

It does most of its work in one season. More must not be expected of it, as it gives quick returns and large profits when properly applied. It tends to sweeten sour land.

When applied broadcast it should be evenly distributed. In applying 100 pounds to an acre, one pound has to be evenly spread over 48 square yards, and this requires care and skill.

It is well to mix it with sand, marl, ashes, land plaster or some other finely divided material of about the same weight in order to secure a more even distribution.

Where plants are grown in hills or rows it should be applied near the growing plants and thoroughly mixed with the soil.

It does not matter whether it is sown in dry or wet weather except that when applied broadcast to crops like cabbage, which have a large leaf surface, it should be done when the leaves are not wet from rain or dew.

It does not blow away, and dews are sufficient to dissolve it. It is not necessary to wait for rain.

It should be sown early in the spring for cereals, just as they are starting to make their first growth; for roots, after they are transplanted or set out.

Autumn sowing is generally not advisable except as an extra top-dressing for Danish or winter cabbage just as they are starting to head, which is practised very profitably by large cabbage growers.

It enables the plant to make use of the necessary mineral elements in the soil to the best advantage.

There are no unknown conditions that enter it, in reference to the solubility, and hence the availability of Nitrate of Soda.

General Points as to Method of Application.

The points to be observed in the use of Nitrate of Soda are: Avoid an excess, do not sprinkle wet foliage with dry Nitrate, and in general Nitrate must not be allowed to come in contact with the stems or leaves of plants. Nitrate of Soda is a nitrated nitrogen and is immediately available as plant food. Applications of Nitrate of Soda may be made at the rate of 100 pounds to the acre. There is no nitrogenous fertilizer in the market at the present time, which sells as low for the nitrogen contained in it. In looking at quotations nitrogen in dried blood, tankages and mixed fertilizers costs anywhere from sixteen to twenty cents per pound. Nitrate is, therefore, the cheapest fertilizer in the market. It should be borne in mind that prices for all agricultural crops have risen proportionately much higher than nitrogenous fertilizers.

Manures.

Dr. Voelcker, F.R.S., made analyses of fresh and rotted farmyard manures. These analyses show a larger percentage of soluble organic matter in rotted than in fresh manure. The fresh manure contains more carbon and more water, while in the rotted manure the Nitrogen is in more available form for root-absorption.

If the process of fermentation has been well managed, both fresh and rotted manures contain the same amounts of Nitrogen, phosphoric acid and potash.

Litter. There should be a sufficient amount of litter to absorb and retain the urine and also the ammonia formed in the decomposition of the manure. Leaves, straw, sawdust, moss, etc., to which is added some peat, muck, or fine, dry, loamy earth, mixed with gypsum (land plaster), may be used for litter. The relative value of the manure is diminished by the use of too much litter, but on the contrary, if insufficient absorbent material is used, too much moisture prevents fermentation and the consequent chemical changes in the nitrogenous constituents of the manure.

Management of Farm-Yard Manure. The best method for the management of farmyard manure is to make and keep it under cover, in sheds, or better still, in covered pits from which there can be no loss by drainage. It should also be kept sufficiently moist, and by the addition of charcoal, peat, or vegetable refuse and gypsum the volatilization of ammonia may be reduced to a minimum. Manure so made is worth 50 per cent. more than that thrown into a heap in the barnyard to be leached by the storms of months before being spread upon the land.

Where pits cannot be provided the manure pile should rest upon a hard, clay bottom, or on a thick layer of peat or vegetable refuse, which acts as an absorbent and prevents the loss of much liquid manure.

The time-honored custom of hauling manure upon the land and of dumping it in small heaps from two to three feet in height, is a wasteful and clumsy practice that should be abandoned by every farmer.

Farm Sewage Disposal. A simple and effectual way of disposing of the night-soil on a farm is to so construct the closet that the urine will at once drain to a lower level, and there be mixed with an equal quantity of quicklime. The solid excrement should be covered daily with a small quantity of quicklime mixed with a little fine charcoal or peat. Such a receptacle can be made by any farmer at comparatively little cost, and will more than compensate for the care it entails by doing away with ill-smelling odors and the disagreeable and often dangerous task of cleaning vaults, besides furnishing a very rich manurial product for admixture with farmyard manure or compost. Such receptacle should be kept in the form of a shallow drawer or box with an inclined bottom, and should rest upon stout runners like a stone boat or drag, so that, at frequent intervals, it can be drawn by a horse to the manure pile or compost heap.

On the bottom of the drawer should be kept a thin layer of quicklime mixed with peat, wood-pile dirt, or loam.

As an alkali, soda has no advantage over potash, since the decomposing action of the soda is rarely due to its alkalinity. If wood-ashes are used for potash the lime carbonate will neutralize the acid properties of the peat, and the growth of the Nitrate ferment will thus be greatly promoted.

Soda, is in rare instances, needful as a plant food; if needed it would be better economy to use soda ash. In these composts the writer invariably substitutes kainit, or other products of the German mines, for common salt.

How to Save Humus.

Sawdust, leaves, cornstalks, tan bark, and all kinds of coarse vegetable materials are more rapidly decomposed by the aid of caustic alkalies than by any other means. Coarse materials, like cornstalks, trimmings from fruit trees, hedges, grape vines, etc., are rich in plant food, and instead of being burned should be composted with potash and lime in separate heaps. More time must be allowed for the decomposition of coarse materials, and they should always be composted in large heaps and kept moist.

Nitration or Nitrification.

The process of nitration in the niter-bed, the compost-heap, or in the soil is precisely the same. The formation of Nitrates is due to the continuous life and development of a micro-organism known as the nitric ferment or nitric bacteria, which lives upon the nitrogenous organic matters, ammonium compounds, and other things present in the soil. The nitric ferment is a microscopic plant somewhat like the yeast used for leavening bread, and for fermenting malt liquors; and under favorable conditions of temperature and moisture, and in the presence of oxygen is propagated with marvelous rapidity in the soil. One of the results of the life of this minute plant is the formation of Nitrates.

Nitration is extremely feeble in winter and at temperatures below 40° F. almost entirely ceases. It is most active at about 98° F. to 99° F., and is more rapid in the dark than in bright sunlight. At temperatures over 100° F. the formation of Nitrates rapidly decreases and at 131° F. entirely ceases. As we have just stated, it has been noticed that the nitric ferment thrives best in the dark, hence, this is one good reason for making compost beds under sheds or in sheltered situations. When so made the conditions for nitrification are more favorable and the beds are protected from the leaching action of storms.

To ensure rapid nitrification all the food elements required by the nitric ferment must be present. The ash ingredients of plants, phosphates, ammonia, carbonaceous matter, and an excess of oxygen must be present.

Peat containing much copperas, coal-tar, gas-lime containing sulphites and sulphides, kill the ferment. The Nitrate ferment is developed during the slow decay of organic matter in all soils.

Materials Used in Making Commercial or Chemical Fertilizers.

Nitrate of Soda or Chile Saltpetre.

Nitrate of Soda or Chile Saltpetre occurs in vast deposits in the rainless districts of the West coast of South America, chiefly in Chile, from whence it is imported to this country for use in chemical manufacture and in agriculture. As imported into the United States, Nitrate of Soda usually contains about fifteen per cent. of Nitrogen. Nitrate of Soda resembles common salt, with which and sodium sulphate it is often adulterated. This salt is at once available as a direct fertilizer. Whenever practicable it should be applied as a top-dressing to growing crops, and if possible the dressings should be given in two or three successive rations.

Nitrate of Soda is usually applied at the rate of from 100 to 200 pounds per acre on land previously dressed with farm-yard manure. To secure an even distribution, the Nitrate should be well mixed with from three to five parts of fine loam or sand.

Much has been said and written about Nitrate of Soda exhausting the soil. This is all a mistake and is the outcome of incorrect reasoning. Nitrate of Soda does not exhaust soils. It does promote the development of the leafy parts of plants, and its effects are at once noticeable in the deep, rich green, and vigorous growth of crops. The growth of plants is greatly energized by its use, for the Nitrate in supplying an abundance of nitrogenous food to plants, imparts to them a thrift and vigor which enables their roots to gather in the shortest time the largest amount of other needed foods from a greater surface of surrounding soil. The thirty-seven to forty per cent. of Soda which Nitrate contains is practically of no use to agricultural plants. In the increased crop obtained by its use there must necessarily be more potash and phosphoric acid than would have been contained in a smaller crop on which the Nitrate of Soda had not been used. The increased consumption of phosphoric acid and potash is due to the increase in the weight of the crop. The office of the Nitrate is to convert the raw materials of the soil into a crop; for we obtain by its use, as Dr. Griffiths has tersely said, "the fullest crop with the greatest amount of profit, with the least damage to the land."

How Used.

On cereals Nitrate of Soda should be used alone or mixed with dry superphosphate and applied as a top-dressing.

On grass lands it may be applied as a top-dressing at the rate of 150 to 200 pounds per acre.

Some of our most successful onion growers use Nitrate of Soda at the rate of from 500 to 700 pounds per acre, applying the Nitrate in three successive top-dressings, the last ration being given when the crop is about half grown.

From what is known of the fertilization action of Nitrate of Soda, the following conclusions may be safely drawn, viz.:

First. Nitrate of Soda is, in most cases, a reliable fertilizer for cereals, roots and grasses, increasing the yield over other nitrogenous fertilizers.

Second. Many crops grown with Nitrate of Soda mature from one to two weeks earlier than when grown with other nitrogenized fertilizers.

Third. The best results are obtained by applying the Nitrate to crops in fractional top-dressings during the active stages of growth.

Fourth. Crops grown with Nitrate of Soda generally have a higher feeding value than those grown with other forms of Nitrogen.

Fifth. Crops grown with Nitrate of Soda seem to resist the attacks of parasitic organisms better than those grown without its aid.

Sixth. Nitrate of Soda does not exhaust the land.

Economy in the Purchase of Fertilizers.

Home Mixtures

Economy in the purchase of fertilizing materials or of agricultural chemicals depends not only on the price paid per pound or per ton, but also on the relation existing between the price paid and the amounts and forms of the Nitrogen, phosphoric acid, and potash furnished. To illustrate, we will assume that two fertilizers, both made from the best class of materials, are offered by a manufacturer at thirty dollars and at thirty-five dollars per ton. The first is guaranteed to contain three per cent. of Nitrogen, seven per cent. of available phosphoric acid, and three per cent. of potash. The second is guaranteed to contain five per cent. of Nitrogen, ten per cent. of available phosphoric acid, and seven per cent. of potash.

We have but to calculate the commercial values of these fertilizers to ascertain their true relation to the prices asked by the manufacturer. By simply multiplying the actual content of Nitrogen, phosphoric acid, and potash by the trade value for these constituents in mixed fertilizers, we find that there is an actual difference of nearly $14 in their commercial values, whereas the difference in price made by the manufacturer is only $5.

The fertilizer materials in the higher priced fertilizers are about thirty-three per cent. cheaper than those in the lower priced article.

As a general rule the more concentrated the form of fertilizing materials in commercial fertilizers, or the higher the grade of unmixed raw materials purchased by the farmer for home mixing, the greater will be the saving in actual cost.

The higher the grade of materials the less will be the expense for freight, mixing, and spreading upon the land.

There are these decided advantages about the mixing of materials at home, viz., each raw material can be separately examined, and if there is any cause for suspecting inferior forms of Nitrogen, phosphoric acid, or potash, samples may be sent to the State Experiment Station for analysis. The detection of error or fraud is more certain and much easier in unmixed raw materials than in mixed fertilizers. Another important advantage of home-mixing is the opportunity afforded the intelligent farmer to adapt the composition of a fertilizer to the special soil requirements of his land and to the wants of the crop to be grown. And, lastly, home mixtures have, as a rule, proved to be much cheaper than ready-made fertilizers. However, the economy of home-mixing should in every instance be determined by actual calculation.

Nitrogen, phosphoric acid, and potash, as we have already seen, are necessary for the complete development of farm crops, and are the constituents most likely to be deficient in cultivated soils; different crops have different capacities for consuming these plant foods, so that when no increase in crop production follows a rational application of one, two, or all three of these constituents the soil evidently contains them in sufficient stores to develop crops to limitations fixed by season and existing climatic conditions. By a careful study of the capacities of different crops for using Nitrogen, phosphoric acid, and potash, we may, within reasonable limits, approximate the quantities, which, under average conditions of crop, soil, and season, should be restored to the land to balance the consumption of growing crops.

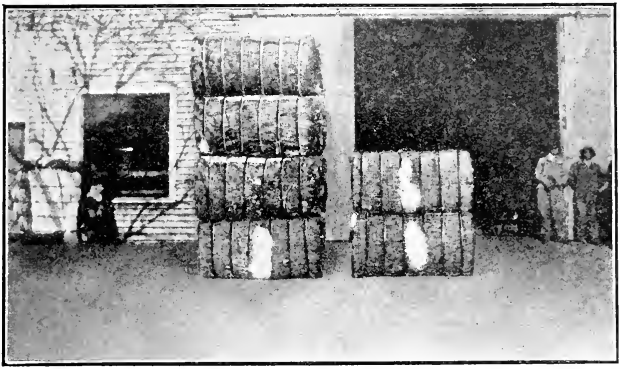
In using fertilizers, or in special crop feeding, it should be borne in mind that lands in a high state of cultivation generally respond to heavy fertilization with much greater immediate profit than those of ordinary fertility.

It is estimated that the total fertilizer business of our country is not far from six million tons. It may be somewhat more, but, accepting six million tons as the figure, it would take four hundred thousand cars to handle this business. Assuming the average fertilizer consumed to be worth only twenty dollars a ton, it would seem certain that forty per cent. of this tonnage is absolutely inefficient and useless, from every standpoint, since such average fertilizer which runs only twenty dollars per ton contains fully forty per cent. of filler. From this standpoint, one hundred sixty thousand cars are engaged once every year for the season in carrying filler material from our fertilizer factories to our farmers, on which our farmers pay the freight. This is really perfectly valueless to the farmer and planter, and of no ultimate value to the transportation company in producing outbound tonnage; neither does it contribute in any way to diminishing the high cost of living,—in fact, it prevents increasing our food supplies, since it compels a large body of men engaged in production, as well as in transportation, from producing anything of value to anybody. It is sheer waste.

The elimination of filler from our fertilizers, and putting in its place an active form of nitrogen to bring up the productive capacity of our fertilizers to the European standard,—since our average contains but two per cent. nitrogen, eight per cent. phosphoric acid and four per cent. potash, whilst the European average contains four and a half per cent. nitrogen, eight per cent. phosphoric acid and four per cent. potash.—is a crying necessity. The money which is now expended by our farmers for fertilizers and their transportation should be expended on material worthy of transportation, for it would immediately create different conditions, and would make the fertilizer communities now served by the railroad immensely more prosperous. Not only would the railroads have more outbound tonnage, but they would have more inbound tonnage, as a result of the increased purchasing capacity of our farmers and planters.

Since we have pretty close to three hundred million acres of lands on which fertilizer could be used, the

Cotton.



Cotton—4 Bales.

The average yield of Five Egyptian acres of cotton where Nitrate of Soda is used at the rate of 100 lbs. or more to the acre.

Cotton—2 Bales.

The average yield of Five United States acres of cotton of average production and average fertilization.

possibilities of increasing the food supplies of all our crops are obvious, since Nitrate has now been recognized by accepted Scientific Authorities as a crop producer of first-rate importance.

The average crop production for six staple crops of different countries is stated hereunder, as is also the average composition of fertilizers used by farmers in the several countries:

Crop	United States	Egypt	Germany	England
Cotton..........	185 lbs.	400 lbs.	....	.....
Oats............	30 bu.	....	48 bu.	45 bu.
Potatoes.........	97.15 bu.	....	199.84 bu.	.....
Sugar Beets......	12 tons	....	16 tons	.....
Tobacco.........	785.49 lbs.	....	1614.70 lbs.	.....
Wheat...........	14 bu.	....	28 bu.	33 bu.
Average Fertilizer	2% Nitrogen* 8% Phos. Acid 4% Potash	4½% Nitrogen 8% Phos. Acid 4% Potash	4½% Nitrogen 8% Phos. Acid 4% Potash	4½% Nitrogen 8% Phos. Acid 4% Potash

* The nitrogen in ready mixed fertilizers in the United States is frequently all inactive, and sometimes never available.

It will be seen that the average crop production of staple crops is very much greater in Europe and Egypt than in this country. In those countries enormous quantities of Chilean Nitrate are used as a fertilizer, and their average fertilizer contains two and a half per cent. more of active Nitrogen, (Nitrate) than ours. This corresponds to about three hundred pounds of Nitrate of Soda in each ton, and this formula eliminates most of the useless filler.

The Home Mixing of Fertilizers

A hundred years ago the farmers of America and Europe had at their disposal but few materials for increasing the fertility of the land. Barnyard manure was then the great fertilizer, but only capable, as we realize now, of restoring but incompletely the plant-food carried away by the crops. Yet barnyard manure was justly esteemed for its fertilizing value, and on many a farm cattle were kept, not because they were in themselves profitable, but because of the manure that they produced. However, for all of the cattle kept on the farms of Europe, the productive power of its soils was declining. At this time the use of bones became prevalent and this marked the beginning of more rational methods of soil treatment.

The Rise of the Fertilizer Mixing Industry.

It was not until the second quarter of the nineteenth century, however, that new and important fertilizer materials came into the market. The increasing number of soil and crop analyses had demonstrated the invariable presence of the essential constituents in both soils and plants; while the numerous vegetation experiments showed that Nitrogen, phosphoric acid and potash were often present in the soil in amounts too small for profitable yields.

There then came into being a great fertilizer mixing industry. Peruvian guano held for a time a prominent place in the agriculture of contemporary Europe. It was not long, however, before the supply of the best grades of guano became depleted, though this did not occur until the chemist pointed the way to new treasures of plant-food. Nitrate of Soda, the most valuable source of commercial Nitrogen at present, came to play an increasingly important role after the middle of the nineteenth century. The potash salts of the German mines became a marketable commodity when the last battles of our civil war were being fought; and when the great conflict was over, the phosphate deposits of South Carolina, and subsequently of Florida and Tennessee, were ready to supply the third important constituent of commercial fertilizers.

The Make-Up of Commercial Fertilizers.

The fertilizers sold to American farmers are valuable in so far as they contain the essential available constituents,—Nitrogen, Phosphoric Acid and Potash. When all are present the fertilizer is said to be *complete*, otherwise it is *incomplete*. It is the aim of the fertilizer mixers to supply to farmers both incomplete and complete fertilizers, chiefly the latter. Furthermore, usage and state legislation compel them to guarantee that their various brands contain a certain proportion of the essential constituents, but, unfortunately for the farmer, they do not require any disclosure whatever as to the availability of the most valuable content, viz., Nitrogen; hence, the attempt to state a *formula* on the bags, or on the tags attached to the latter, is a wholly incomplete affair. As an example, we may take a fertilizer whose formula is 4-8-10, that is, one containing 4 per cent. of Nitrogen, 8 per cent. of phosphoric acid and 10 per cent. of potash.

Materials of various qualities and grades are employed for the preparation of so-called complete fertilizers, as may be seen from the following list:

Materials Furnishing Nitrogen.	Materials Furnishing Phos. Acid.	Materials Furnishing Potash.
Nitrate of Soda Nitrate of Lime, Sulphate of Ammonia, Calcium Cyanamid, Dried Blood, Tankage, Fish Scrap, Cottonseed Meal, Horn and Hoof Meal, Hair and Wool, Leather Scrap.	Thomas Slag Acid Phosphate, Bone Meal, Phosphatic Guano, Fish Scrap, Bone Tankage.	Potash Salts (from Germany), Unleached Wood Ashes.

Aside from these materials, there are others that are occasionally employed by mixers to furnish filler.

Availability in Fertilizers.

In the making of complete goods from the various straight fertilizers the mixer is largely guided by the *cost*, as well as the *quality* of the latter. The question of quality is particularly important, since *no high grade fertilizer can be made from inferior ingredients.* The conception of quality has been gradually developed by investigators and farmers and the term *Availability* is commonly employed when the value of straight or mixed fertilizers is considered. We call a fertilizer Available when the Nitrogen, phosphoric acid or potash contained in it may be readily used by the crop; and not Available when it is transformed so slowly in the soil as to offer but little plant-food to the crop at any one time. A striking illustration of the significance of Availability in fertilizers is found in the action of comparatively small amounts of Nitrate on grass or grain applied early in the spring. It has been repeatedly observed that soils containing as much as .15 per cent. of Nitrogen, or 6,000 pounds per acre-foot out of a total of 2,000 tons, which such an acre-foot weighs, and capable of yielding about one ton of hay per acre, may be made to produce two tons of hay when top-dressed in the spring with only 100-150 pounds of Nitrate. At first it may seem strange that the 23 or 24 pounds of Nitrogen in 150 pounds of Nitrate of Soda should produce this magic effect, when measured against the 6,000 pounds of ordinary Nitrogen already in the soil. But the mystery is made clear to us when we remember that Nitrate of Soda is a soluble food that may be directly taken up by plant-roots, whereas the Nitrogen of the soil itself is nearly all locked up in inert humous compounds which must first pass through the various stages of Nitration before they become available. With some qualifications a similar comparison could be made between the phosphoric acid in ground phosphate rock, known as "floats," and that in acid phosphate; or between potash in feldspar rock or clay and that in sulphate of potash.

In order to protect the farmer against fraud, fertilizer laws have been enacted in most of the Eastern States. These laws compel the mixers and dealers to *guarantee* their goods, that is, to state on the bags or tags how much Nitrogen, phosphoric acid and potash their fertilizers contain; furthermore, they are also compelled, but in an incomplete measure, to guarantee the quality, i. e., Availability, of the plant-food sold by them. The farmer is given, however, a fair measure of protection in so far as the phosphoric acid and potash purchased by him are concerned. He is told definitely how much phosphoric acid is present in available form. He knows, also, that the potash in mixed fertilizers is derived almost exclusively from the German potash salts, all of them readily available. On the other hand, he is given little protection in his purchase of Nitrogen. To be sure, the fertilizer laws compel the mixer to state *how much* Nitrogen there is present in this commodity; yet he is not compelled to tell the exact source or availability of the Nitrogen employed by him. From the consumer's standpoint this is a serious question, since

Barley.

Pots manured with Phosphoric Acid, Potash and Nitrate of Soda.

Nitrate of Soda	none	1 gr.	2 gr.	3 gr.

In agricultural practice from 75 lbs. to 200 lbs. of Nitrate of Soda per acre is applied in one or more dressings.

a pound of Nitrogen costs about four times as much as a pound of either phosphoric acid or potash. If the law required merely the stating of the total per cent. of phosphoric acid or of potash without giving the amount of soluble or available percentages of the same, how incomplete the essential information would be as to the nature or value of the "so-called" complete fertilizers. More than that, the Nitrogen is not only costly but calls for greater farming skill in its use, lest the yields and quality of the produce be unfavorably affected. The Activity as well as the Availability of Nitrogen in materials like leather scrap, hair or peat is but one-fifth to one-tenth as much as that in Nitrate of Soda, and we can therefore realize the necessity of complete knowledge as to the agricultural use of Nitrogen.

It is conceded by all authorities that more accurate knowledge in this direction may be secured by the practice of *HOME-MIXING*, that is, by the purchase of the straight fertilizers and their mixing at home on the farm in amounts and proportions best suited for any particular soil and crop.

Advantages of Home Mixing.

The practice of home-mixing has its friends as well as its opponents, but when all the arguments pro and con are summed up the decision must be entirely in its favor. The advantages claimed for *home-mixing* are:—

1. *Better adaptation to soil and crop.* Soils vary in their chemical composition, and in their previous history, as to cropping and fertilization. One soil may be deficient in available Nitrogen, another deficient in available phosphoric acid. In one instance a heavy application of manure, a crop of crimson clover, or alfalfa stubble may have been plowed under; and in a second instance a thin timothy sod. Evidently a crop of corn would not find the same amounts and proportions of food in these cases, and it is therefore idle to assume that a so-called corn fertilizer, whatever its composition, would prove as efficient in the one case as in the other.

Again, it is common knowledge that some crops are particularly grateful for applications of Nitrogen, while others are responsive to applications of phosphoric acid or of potash. Yet even here the soil and climate exert an important modifying influence. For instance, clovers and other legumes are capable of securing their Nitrogen from the air and, *except in the early stages of growth*, are independent of the supply in the soil or fertilizers. On the other hand, they require large amounts of potash, phosphoric acid and lime. Nevertheless, certain limestone soils require only applications of potash, while many silt loam or clay soils require only applications of phosphoric acid. In a word, then, no single formula for any particular crop can be devised to suit all soils and seasons. When the mixing is done on the farm, proper adjustment can be made to suit local conditions, known best by the farm manager after adequate experience.

One advantage of *Home*-Mixing is that the farmer may make any combination of plant-food he wishes, and know the form and availability of the ingredients of his own fertilizer, and he will save not only the high price paid for filler, but also the cost of transporting it.

2. *Better information concerning the quality of materials.* The present high prices of organic ammoniates are forcing the fertilizer mixers to employ various organic materials of inferior quality. Since the fertilizer laws do not require any distinction between the sources of Nitrogen, mixers feel free to meet competition and to reduce the cost of mixing by employing inert materials like leather-scrap, hair, wool and garbage tankage. Moreover, even the better grades of organic ammoniates like dried blood, tankage, and ground fish are now adulterated more than formerly. *Home*-mixing protects the farmer against the use of inferior materials and permits him to purchase his Nitrogen in the readily available forms.

Many of the ingredients used by the manufacturers of "complete" fertilizers are produced directly or indirectly by themselves. Others, like Nitrate of Soda, potash salts and basic slag, are not produced in this country. Naturally the manufacturers will use as much as possible of the materials produced by themselves, on which they make both a raw material and a mixing profit, and spend as little as possible for imported materials on which they can make but one profit.

Carrots.

Pots manured with Phosphoric Acid, Potash and Nitrate of Soda.

Nitrate of Soda	none	1½ gr.	3 gr.	4½ gr.

In agricultural practice from 2 cwt. to 4 cwt. of Nitrate of Soda per acre is applied in one or more dressings.

The "complete" fertilizer manufacturers use large quantities of low grade materials which the farmers would not buy for *Home*-Mixing because of the doubtful value of the Nitrogen owing to its not being available, that is, indigestible as plant food. But the manufacturer finds them doubly valuable as filler, because he can label his goods as containing so and so much Nitrogen, notwithstanding its indigestible quality as a plant food.

3. *Lower cost per unit of plant-food.* As shown by the analyses and valuations of fertilizers made by different experiment stations, the so-called *overhead* charges made by the mixers amount, on the average, to more than six dollars per ton. Otherwise stated, the farmer who buys mixed fertilizers is made to pay about six or seven dollars per ton for mixing, bagging, shipping, agents' commissions, profit, long credit, etc. The overhead charges tend to increase the cost per unit of plant-food in all fertilizers, and to a particularly marked extent in the cheaper brands. Home-mixing enables the farmer to secure available plant-food at a lower cost per unit.

4. *More profitable returns from the use of fertilizers may be secured when one understands their composition and the functions of their single ingredients.* The man who takes the trouble to make himself acquainted with the origin, the history and the action of different fertilizers is perforce bound to secure larger returns from them than the man who blindly follows the experience of others. For this reason the *home*-mixing of fertilizers is an educational factor of great importance. The farmer who does his own mixing is bound to observe the effect of season, of crop and of rotation. He is bound to learn something of the particular influences of Nitrogen, of phosphoric acid and of potash. In the course of time he is led to experiment for himself, with different mixtures, proportions and methods of application, and by doing all these things he becomes more skilled and successful in the business of crop production.

The opponents of *home*-mixing have claimed, on their part, that the farmer cannot prepare mixtures as uniform as those made at the factory. They have also claimed that the mixtures made at the farm are more costly than similar mixtures made at the factory. As to the first of these objections, it has been demonstrated by most of the experiment stations in the East and the South that home-mixtures can be made mechanically as satisfactory as the best of the commercial brands. It is merely necessary to screen the single ingredients and to use some sort of a filler like dry peat or fine loam to prevent caking. The second objection is not at all borne out by the actual experience of farmers who have been using home-mixtures for years.

Equipment and Methods for Home-Mixing.

The equipment required for home-mixing is very simple and inexpensive. It consists of a screen with three (3) meshes to the inch, and about 4-5 feet long and 1½ to 2 feet wide, a shovel with square point, an iron rake, and platform scales.

The mixing may be done on a tight, clean barn floor, and a heavy wooden post is useful for crushing big lumps of the material; frequently the use of a sieve may be dispensed with by this means.

Previous to mixing, the materials are screened, the lumps broken up and again screened. The mixing may then be best accomplished by spreading out the most bulky constituent in a uniform layer about six inches thick. The next most bulky constituent is then similarly spread out on top of the first, and is followed in its turn by the others until the pile is complete. The several layers are then thoroughly mixed by shovelling the entire heap three or four times. Thorough mixing is shown by the absence of streaks of different materials. The mixture may be put in bags or other convenient receptacles and kept in a dry place until needed.

In mixing various materials some knowledge is required concerning the action of different ingredients upon each other. Such knowledge will prevent the danger of loss of constituents or the deterioration of quality. The materials that should not be employed together in mixed fertilizers are known as incompatibles. As is pointed out in this connection in Farmers' Bulletin No. 225, U. S. Department of Agriculture, it should be remembered that "(1) When certain materials are mixed chemical changes take place which result in loss of a valuable constituent, as when lime is mixed with guano, Nitrogen escapes; or in a change of a constituent to a less available form, as when lime is mixed with superphosphates, the phosphoric acid is made less soluble; and (2), mixtures of certain materials, as, for example, potash salts and Thomas Slag, are likely to harden or 'cake,' and thus become difficult to handle if kept some time after mixing."

Potash salts may be mixed with Thomas phosphate powder, but acid phosphate should not be mixed with quick lime, nor sulphate of ammonia with basic slag.

The modern farmer in America is beginning to understand the nature of straight fertilizers as well as the farmer in Germany. He knows fairly well the character and qualities of the materials now used in mixing fertilizers; and can thus form his own judgment as to what is best for the different crops and soils.

It is better to spread fertilizers broadcast by hand, or by a top-dressing machine; fertilizer drills, as a rule, are not of sufficient capacity. Broadcasting is always a more thorough method of applying fertilizers, as it gives the following crops a better opportunity to utilize all the material and prevents too much concentration of plant food by the plants. It also gives a better root development, since the plants are compelled to utilize a larger feeding area to no disadvantage, since it is nature's way.

It is generally better to harrow in fertilizers after they are applied, except on the seeded crops or on sod lands.

Calculations for Mixing Fertilizers.

As an example of how the proportions of the different ingredients in a mixture may be calculated, let it be assumed that a farmer wishes to prepare a 4-8-6 potato fertilizer out of Nitrate of Soda containing 15 per cent. of Nitrogen; acid phosphate containing 16 per cent. of available phosphoric acid and sulphate of potash containing 50 per cent. of actual potash. Remembering that each one hundred pounds of the required mixture is to contain 4 pounds of available Nitrogen, 8 pounds of available phosphoric acid and 6 pounds of available potash, we may best determine the amounts of each per ton by multiplying the given figures by 20. Thus:--

4 x 20 =	80 lbs.	Available Nitrogen per ton.
8 x 20 =	160 "	Available phosphoric acid per ton.
6 x 20 =	120 "	Available potash per ton.

Hence each ton of the mixture is to contain 80 pounds of available Nitrogen, 160 pounds of available phosphoric acid and 120 pounds of available potash.

We next determine the amount of each ingredient necessary to furnish the required quantities of plant-food. Since each one hundred pounds of Nitrate contains 15 pounds of Nitrogen, the 80 pounds of Nitrogen required would represent as many hundreds or fractions thereof, as 15 is contained in 80; or

80 ÷ 15% =	533 lbs.	Nitrate of Soda
160 ÷ 16% =	1000 lbs.	Acid Phosphate
120 ÷ 50% =	240 lbs.	Sulphate of Potash
Filler......	227 lbs.	Fine dry loam, or peat, or land plaster (gypsum)
	2000 lbs.	

Calculations of Formula of Mixed Materials.

It is desirable, at times to determine the proportions of plant-food in any given mixture. For instance, a mixture is made up of 200 pounds of Nitrate of Soda, 200 pounds of tankage, 1,000 pounds of acid phosphate and 200 pounds of sulphate of potash, what is the formula if the Nitrate contains 15 per cent. of available Nitrogen, the tankage 5 per cent. of Nitrogen and 10 per cent. of phosphoric acid, the acid phosphate 16 per cent. of phosphoric acid, and the sulphate of potash 50 per cent. of potash. The amounts of plant food would then be:—

		Nitrogen lbs.	Phos. Acid lbs.	Potash lbs.
Nitrate of Soda..........	200 lbs. x .15 =	30	..	..
Tankage................	200 lbs. x .05 =	10	..	..
Tankage................	200 lbs. x .10 =	..	20	..
Acid Phosphate..........	1000 lbs. x .16 =	..	160	..
Sulphate of Potash.......	200 lbs. x .50 =	..	..	100
Total................		40	180	100

A ton of the mixture would thus contain 40 pounds of Nitrogen, 180 pounds of phosphoric acid and 100 pounds of potash. To get the weight per hundred we divide each of these amounts by 20, obtaining a formula that may be represented by 2-9-5.

To Calculate the Value of Mixed Fertilizers.

When acid phosphate with 16 per cent. available phosphoric acid can be bought at $15.50 per ton; when sulphate of potash with 48 per cent. of potash can be bought at $50.00 per ton, and when Nitrate of Soda containing 15 per cent. of Nitrogen can be bought at $52.00 per ton; what would be the value of a mixed fertilizer guaranteed to contain 6 per cent. of available phosphoric acid, 5 per cent. of potash, and 3.25 per cent. of Nitrogen?

As a preliminary step we have to determine the cost per pound of the constituents in the straight fertilizers. Thus:—

2000 lbs. of Nitrate of Soda x .15 = 300 lbs. available Nitrogen
$52.00 divided by 300 lbs. = $0.173 per lb.

2000 lbs. of Acid Phosphate x .16 = 320 lbs. Phosphoric Acid
$15.50 divided by 320 lbs. = $0.048 per lb.

2000 lbs. of Sulphate of Potash x .48 = 960 lbs. actual Potash
$50.00 divided by 960 lbs. = $0.052 per lb.

Next comes the determination of the total plant-food in the mixed fertilizer. Thus:—

3.25%x2000 lbs. = 65 lbs. Nitrogen which at $0.173 per lb. =		$11.25
6.00%x2000 lbs. = 120 lbs. Phosphoric Acid which at	0.048 per lb. =	5.76
5.00%x2000 lbs. = 100 lbs. Potash which at	0.052 per lb. =	5.20
		$22.21

Assuming that all the Nitrogen in the mixed fertilizer was derived from Nitrate, the value per ton would be $22.21, exclusive of the cost of mixing and bagging.

Straight Fertilizer Formulas for Farm, Fruit, and Market Garden Crops.

The primary object in the preparation of fertilizer formulas is to show the kinds and amounts of materials to use in order to provide in a mixture good forms and proportions of the constituents, which shall be in good mechanical condition. It is not believed that any one formula is the *best* for all conditions, these vary as widely as the soils and different methods of management.

Substitutions That May Be Made.

It is not intended that the kinds of materials shall be absolutely adhered to, for in many cases substitutions of others may be made not only without materially changing the composition of the resultant mixture, but which may also reduce its actual cost. For example, tankage or dried ground fish may be substituted for cotton-seed meal in any mixture, and if the right grades are obtained, will substitute the amount of nitrogen in it, though it may be in a slightly less available form; besides, the former contains considerably more phosphoric acid. In other instances, dried blood may be substituted with advantage for the tankage or cotton-seed meal, though naturally one pound of high grade blood will furnish practically twice as much nitrogen as one pound of the others. Again, bone tankage, which is quite similar to ground bone in its composition, may be substituted for bone, and *vice versa,* the substitution depending upon the cost, as the availability of the constituents is not materially different. In the case of potash, the sulphate may be substituted for the muriate without changing the percentage of actual potash in the mixture; whereas if kainit is substituted for the higher grades, four times the weight must be included in order to obtain the same amount of potash, and the amount of the mixture applied per acre must be doubled in order to obtain the same number of pounds of the constituents for a given area. For example, if in a mixture of

Nitrate of Soda..........................	100 lbs.
Ground Bone..............................	100 "
Sulphate of Potash.......................	100 "

400 pounds of kainit is substituted for the 100 pounds of sulphate of potash, the percentage composition of the mixture would be just one-half the former, as the constituents are distributed throughout twice the weight.

Importance of Mechanical Condition.

In the next place, care should be exercised in the preparation of mixtures, in order to obtain good mechanical condition. It is sometimes a difficult matter to obtain a dry mixture from the use of purely mineral fertilizing materials, as superphosphates, and muriate of potash, or kainit—it is apt to become pasty in the drill or planter, whereas, if some dry material, as bone or tankage, is added, the mixture is much improved and the composition not materially affected.

The Kinds and Amounts to Apply.

It should also be remembered that the suggestions in reference both to the particular form of the constituents and the amounts to be applied have reference to their application under average conditions of soil and methods of practice, and as a supplement to the manures of the farm. Where a definite system of rotation is used, and the materials are applied with the purpose of providing the specific crop with the constituents especially needed, the formulas may be very materially changed. Where the condition of soil is not good, or where manures are not used, the amounts recommended should be largely increased, practically doubled in most cases, and also, particularly for the cereals, a greater proportion of nitrogen should be used. As a rule, soils that are not in good condition will require a larger application of fertilizers to obtain the same unit of increase than those in good condition, because in the first case they do not permit the ready penetration of the roots and the easy distribution of the constituents. The indiscriminate use of fertilizers on poor soils is seldom followed by as large a return per unit of plant food applied as where systematic methods obtain.

Methods of Application.

The method of application should depend upon the character of the soil, the crop and the material. On good soils and for crops which require large quantities, a part at least, of the material should be applied broadcast and thoroughly worked into the surface-soil; the remainder may be used in the row at the time of seeding or setting the plants. It is particularly desirable that formulas that are rich in potash should be in part broadcasted, in order that this element may be thoroughly intermingled with the soil, as the rate at which this constituent fixes, particularly on soils of a clayey nature, is very rapid, and unless thoroughly harrowed in the fixing will take place largely at the surface, and thus not be within reach of the feeding roots. On sandy soils, and for such crops as sweet potatoes, the concentration of the fertilizer in the row is more desirable than in the case of good soils and for white potatoes, though the minerals phosphoric acid and potash may be distributed in part. When applied in the row for sweet potatoes, it is desirable that it should be done two or three weeks, at least, before the plants are set, thus avoiding possible injury from the excess in the soil.

Most manufacturers and dealers in fertilizers are willing to supply farmers with the materials suggested, or to mix them at reasonable rates.

If you cannot conveniently get all the materials for mixing your formulas and can secure any reputable brand of ordinary commercial fertilizer, buy a bag of Nitrate of Soda and mix it with four to six bags of such commercial fertilizer; and the mixing may be done on your barn floor. You will thereby improve and fortify the brand you are buying in a way to vastly enhance its crop-making powers.

If the Nitrate should happen to be lumpy, the use of a straight, heavy fence post, rolled over it two or three times will reduce it to splendid condition for home-mixing.

One hundred pounds of Nitrate of Soda is equal in bulk to about one bushel, or 25 pounds to about one peck.

Materials Not To Be Mixed.

Certain ammoniates contain iron, and if mixed with acid phosphate you will lose a considerable portion of your available phosphoric acid.

Lime should not be mixed with sulphate of ammonia and materials containing lime, should not be used in this connection without advice from an experienced fertilizer chemist.

Excessive quantities of lime should not be mixed with superphosphate, barnyard manure or bone meal.

Sulphate of ammonia should not be mixed with Thomas slag and Norwegian Nitrate.

Basic slag should not be mixed with sulphate of ammonia, blood or tankage as the lime affects these materials and releases ammonia. If mixed with kainit it must be applied shortly after mixing.

Cyanamid must not be mixed directly with sulphate of ammonia, but if mixed according to directions will give good results.

Home-Mixing Table.

To ascertain the quantity of each material necessary to make 1,000 pounds of Fertilizer of any desired analysis.

Percentage Required.	Available Nitrogen from Nitrate of Soda.	Available Phosphoric Acid.		Available Potash from Sulphate of Potash.
		From 14% Acid Phosphate.	From 16% Acid Phosphate.	
1%	67 lbs.	71 lbs.	63 lbs.	21 lbs.
2%	133 "	143 "	125 "	42 "
3%	200 "	214 "	188 "	63 "
4%	267 "	286 "	250 "	83 "
5%	333 "	357 "	313 "	104 "
6%	400 "	429 "	375 "	125 "
7%	467 "	500 "	438 "	146 "
8%	533 "	571 "	500 "	167 "
9%	600 "	643 "	563 "	188 "
10%	667 "	714 "	625 "	208 "

Example: A common and profitable formula for Oats is 4-7-5, that is 4 per cent. Nitrogen, 7 per cent. phosphoric acid, 5 per cent. potash. From the table we ascertain that 4 per cent. available Nitrogen is obtained by using 267 pounds Nitrate of Soda, 7 per cent. available phosphoric acid is obtained by using 438 pounds 16 per cent. phosphate and 5 per cent. available potash is obtained by using 104 pounds sulphate of potash, making a total of 809 pounds which contains the same amount of plant food as 1,000 pounds of 4-7-5 ready-mixed fertilizer. Should it be desired to make an even thousands pounds, add a sufficient amount of fine dry loam.

Formulas for Farm Crops.

Corn.

(No. 1)

Nitrate of Soda	200 lbs.
Acid Phosphate	500 "
Sulphate of Potash	100 "
Fine Dry Loam	200 "
	1,000 lbs.

Application at the rate of 600 pounds per acre.

Composition:—Available Nitrogen 3.00 per cent.; available phosphoric acid 8.00 per cent.; available potash 4.80 per cent.

(No. 2)

Nitrate of Soda	150 lbs.
Acid Phosphate	500 "
Sulphate of Potash	100 "
Fine Dry Loam	250 "
	1,000 lbs.

Application at the rate of 600 pounds per acre.

Composition:—Available Nitrogen 2.25 per cent.; available phosphoric acid 8.00 per cent.; available potash 4.80 per cent.

Formula No. 1 is best suited for sandy loams or soils. Formula No. 2 is for medium and heavy loams.

Oats and Spring Wheat.

(No. 1)

Nitrate of Soda	250 lbs.
Acid Phosphate	450 "
Sulphate of Potash	100 "
Fine Dry Loam	200 "
	1,000 lbs.

Application at the rate of 400 pounds per acre.

Composition:—Available Nitrogen 3.75 per cent.; available phosphoric acid 7.20 per cent.; available potash 4.80 per cent.

(No. 2)

Nitrate of Soda	200 lbs.
Acid Phosphate	500 "
Sulphate of Potash	100 "
Fine Dry Loam	200 "
	1,000 lbs.

Application at the rate of 400 pounds per acre.

Composition:—Available Nitrogen 3.00 per cent.; available phosphoric acid 8.00 per cent.; available potash 4.80 per cent.

Formula No. 2 is best suited for use in connection with a leguminous green manure.

Winter Wheat, Rye and Hay or Grass Lands.

(No. 1)

Nitrate of Soda	100 lbs.
Acid Phosphate	600 "
Muriate of Potash	50 "
Fine Dry Loam	250 "
	1,000 lbs.

Application at the rate of 400 pounds per acre.

Composition:—Available Nitrogen 1.50 per cent.; available phosphoric acid 9.60 per cent.; available potash 2.40 per cent.

(No. 2)

Nitrate of Soda	200	lbs.
Acid Phosphate	500	"
Sulphate of Potash	100	"
Fine Dry Loam	200	"
	1,000	lbs.

Application at the rate of 400 pounds per acre.

Composition:—Available Nitrogen 3.00 per cent.; available phosphoric acid 8.00 per cent.; available potash 4.80 per cent.

Mixture No. 1 is best adapted for heavy soils; mixture No. 2, for medium and light loams.

Barley.

Nitrate of Soda	250	lbs.
Acid Phosphate	450	"
Sulphate of Potash	100	"
Fine Dry Loam	200	"
	1,000	lbs.

Application at the rate of 400 pounds per acre.

Composition:—Available Nitrogen 3.75 per cent.; available phosphoric acid 7.20 per cent.; available potash 4.80 per cent.

Clovers, Alfalfa, Cow Peas, Soy Beans and Vetch.

Nitrate of Soda	70	lbs.
Acid Phosphate	550	"
Sulphate of Potash	100	"
Fine Dry Loam	280	"
	1,000	lbs.

Application at the rate of 300–500 pounds per acre.

Composition:—Available Nitrogen 1.05 per cent.; available phosphoric acid 8.80 per cent.; available potash 4.80 per cent.

Cotton.

Nitrate of Soda	250 lbs.
Acid Phosphate	600 "
Sulphate of Potash	50 "
Fine Dry Loam	100 "
	1,000 lbs.

Application at the rate of 400 pounds per acre.

Composition:—Available Nitrogen 3.75 per cent.; available phosphoric acid 9.60 per cent.; available potash 2.40 per cent.

Rice.

Nitrate of Soda	100 lbs.
Acid Phosphate	800 "
Sulphate of Potash	100 "
	1,000 lbs.

Application at the rate of 300 pounds per acre. Apply soon after mixing.

Composition:—Available Nitrogen 1.50 per cent.; available phosphoric acid 12.80 per cent.; available potash 4.80 per cent.

Tobacco.

Nitrate of Soda	540 lbs.
Acid Phosphate	100 "
Sulphate of Potash	200 "
Fine Dry Loam	160 "
	1,000 lbs.

Application at the rate of 1,000 pounds per acre.

Composition:—Available Nitrogen 8.10 per cent.; available phosphoric acid 1.60 per cent.; available potash 9.60 per cent.

As a general rule, and subject to any special soil conditions, we recommend that the above Nitrate of Soda mixture intended to be applied to the tobacco crop be given in three equal dressings. The first of these should be incorporated with the soil just before the planting out, the second should be given as a top dressing at the time of the first hoeing and the last instalment, in the same manner, about a fortnight or three weeks later.

Sweet Potatoes.

Nitrate of Soda	200 lbs.
Acid Phosphate	550 "
Sulphate of Potash	150 "
Fine Dry Loam	100 "
	1,000 lbs.

Application at the rate of 1,000 pounds per acre.

Composition:—Available Nitrogen 3.00 per cent.; available phosphoric acid 8.80 per cent.; available potash 7.20 per cent.

Early and Late Irish Potatoes.

(No. 1)

Nitrate of Soda	320 lbs.
Acid Phosphate	480 "
Sulphate of Potash	100 "
Fine Dry Loam	100 "
	1,000 lbs.

Application at the rate of 1,000 pounds per acre.

Composition:—Available Nitrogen 4.80 per cent.; available phosphoric acid 7.68 per cent.; available potash 4.80 per cent.

In order to secure a satisfactory mechanical condition, this mixture will require about 300-400 pounds additional of fine dry loam for each 1,000 pounds of material.

(No. 2)

Nitrate of Soda	260 lbs.
Acid Phosphate	440 "
Sulphate of Potash	100 "
Fine Dry Loam	200 "
	1,000 lbs.

Application at the rate of 1,000 pounds per acre.

Composition:—Available Nitrogen 3.90 per cent.; available phosphoric acid 7.00 per cent.; available potash 4.80 per cent.

Hops.

Nitrate of Soda	600 lbs.
Acid Phosphate	200 "
Sulphate of potash	100 "
Filler	100 "
	1,000 lbs.

Application at the rate of 1,000 pounds per acre.

Composition:—Available Nitrogen 9.00 per cent.; available phosphoric acid 3.20 per cent.; available potash 4.80 per cent.

Formula for Market Garden Crops

Asparagus, Beans, Beets, (early), Cabbage, Carrots, Cauliflower, Celery, Cucumbers, Egg-Plant, Endive, Kale, Lettuce, Muskmelons, Onions, Peas, (early), Peppers, Pumpkins, Radishes, Spinach, Squash, Tomatoes and Watermelons.

Nitrate of Soda	300 lbs.
Acid Phosphate	400 "
Sulphate of Potash	100 "
Fine Dry Loam	200 "
	1,000 lbs.

Application at the rate of about 1,000 pounds per acre, at the time of seeding and an additional application at the rate of about 500 pounds to be made between the rows later in the season.

Composition:—Available Nitrogen 4.50 per cent.; available phosphoric acid 6.40 per cent.; available potash 4.80 per cent.

Formulas for Fruits and Berries

Apples, Pears, Peaches, Plums, Grapes, Currants, Strawberries, Raspberries, Blackberries, and Gooseberries.

(No. 1)

Nitrate of Soda........................	300 lbs.
Acid Phosphate........................	400 "
Sulphate of Potash......................	100 "
Fine Dry Loam........................	200 "
	1,000 lbs.

Applications at the rate of about 1,000 pounds per acre for berries and 400-800 pounds for fruit trees.

Composition:—Available Nitrogen 4.50 per cent.; available phosphoric acid 6.40 per cent.; available potash 4.80 per cent.

(No. 2)

Nitrate of Soda........................	200 lbs.
Acid Phosphate........................	300 "
Sulphate of Potash......................	100 "
Fine Dry Loam........................	400 "
	1,000 lbs.

Application at the rate of about 1,000 pounds per acre for berries and 400-800 pounds for fruit trees.

Composition:—Available Nitrogen 3.00 per cent.; available phosphoric acid 4.80 per cent.; available potash 4.80 per cent.

Formula 1 is best adapted for medium and heavy soils, Formula 2 for sandy soils.

Formulas for Citrus Fruits

Young Orange Trees.

Nitrate of Soda........................	350 lbs.
Acid Phosphate........................	350 "
Sulphate of Potash....................	100 "
Fine Dry Loam........................	200 "
	1,000 lbs.

Application at the rate of 1,000 pounds per acre.

Composition:—Available Nitrogen 5.25 per cent.; available phosphoric acid 5.60 per cent.; available potash 4.80 per cent.

Old Orange Trees.

Nitrate of Soda........................	375 lbs.
Acid Phosphate........................	435 "
Sulphate of Potash....................	90 "
Fine Dry Loam........................	100 "
	1,000 lbs.

Application at the rate of 1,600 pounds per acre.

Composition:—Available Nitrogen 5.62 per cent.; available phosphoric acid 7.96 per cent.; available potash 4.32 per cent.

Mandarin Oranges.

Nitrate of Soda........................	375 lbs.
Acid Phosphate........................	420 "
Sulphate of Potash....................	80 "
Fine Dry Loam........................	125 "
	1,000 lbs.

Application at the rate of 1,200 pounds per acre.

Composition:—Available Nitrogen 5.62 per cent.; available phosphoric acid 6.72 per cent.; available potash 4.00 per cent.

Grape Fruit.

Nitrate of Soda	375 lbs.
Acid Phosphate	435 "
Sulphate of Potash	90 "
Fine Dry Loam	100 "
	1,000 lbs.

Application at the rate of 1,800 pounds per acre.

Composition:—Available Nitrogen 5.62 per cent.; available phosphoric acid 7.96 per cent.; available potash 4.32 per cent.

Lemons.

Nitrate of Soda	375 lbs.
Acid Phosphate	435 "
Sulphate of Potash	90 "
Fine Dry Loam	100 "
	1,000 lbs.

Application at the rate of 1,600 pounds per acre.

Composition:—Available Nitrogen 5.62 per cent.; available phosphoric acid 7.96 per cent.; available potash 4.32 per cent.

Formulas for Olives.

Young Olive Trees.

Nitrate of Soda	300 lbs.
Acid Phosphate	450 "
Sulphate of Potash	150 "
Fine Dry Loam	100 "
	1,000 lbs.

Application at the rate of 660 pounds per acre.

Composition:—Available Nitrogen 4.50 per cent.; available phosphoric acid 7.20 per cent.; available potash 7.20 per cent.

Old Olive Trees.

Nitrate of Soda	260 lbs.
Acid Phosphate	520 "
Sulphate of Potash	85 "
Fine Dry Loam	135 "
	1,000 lbs.

Application at the rate of 1,150 pounds per acre.

Composition:—Available Nitrogen 3.90 per cent.; available phosphoric acid 8.32 per cent.; available potash 4.08 per cent.

GENERAL DIRECTIONS FOR THE USE OF NITRATE OF SODA ON STAPLE CROPS.

We never recommend the use of Nitrate of Soda alone except at the rate of one hundred pounds to the acre, for seeded crops and two bundred pounds to the acre for cultivated crops. It may be thus safely and profitably used without other fertilizers. It may be evenly applied at this rate as a broadcast top-dressing, by hand, or by machine, in the Spring of the year, as soon as crops begin rapid, new growth. At this rate very satisfactory results are usually obtained without the use of any other fertilizer, and soda residual, after the nitrogenous food of this chemical is used up by the plant, has a perceptible effect in sweetening sour land. One hundred pounds of Nitrate is equal in bulk to about one bushel.

When it is desired to use a larger amount than one hundred pounds of Nitrate per acre for seeded crops (or two hundred pounds per acre for cultivated crops) there should be present some form of available phosphatic and potassic plant food, and we recommend two hundred pounds of acid phosphate and one hundred pounds of sulphate of potash.

In most of our Grass experiments where Nitrate was used alone at the rate of only one hundred pounds per acre, not only was the aftermath, or rowen much improved, but in subsequent seasons, with no further application of fertilizers to the plots a decidedly marked effect was noticed, even on old meadows. This speaks very well indeed for Nitrate of Soda not leaching out of the soil. The readily soluble elements of fertility are the readily available elements. The natural capillarity of soils, doubtless, is in most instances a powerful factor in retaining all readily soluble elements of fertility, otherwise all the fertility of the world in our humid regions would, in a season or two, run into the ocean, and be permanently lost. This is mentioned on account of certain critics having taken the trouble to object to the use of Nitrate on the ground that it would leach away. A case is yet to be seen where the after effects of Nitrate are not distinguishable, and in most cases such effects have been marked. The two thousand tons of active top soil in an acre of land have a powerful holding capacity for all the useful available elements of fertility. These 2,000 tons form the part usually subject to cultivation and might be called service soil.

For market gardening crops, hops, sugar-beets and other cultivated crops, two hundred pounds of Nitrate per acre may be used to great advantage.

When the above amounts of phosphatic and potassic fertilizers are used, as much as two hundred and fifty pounds of Nitrate, or even more, may be applied with profit.

If you have any reason to suspect adulteration of Nitrate, send a pound or so of it to your Experiment Station for analysis, giving date of purchase, full name and address of dealer and of the company which the seller represents, with full description of marks on the bag or bags from which you draw the sample.

On the Pacific Coast, Nitrate may be applied as a top-dressing after the heavy Spring rains are over, but before crops attain much of a start; although recent experience in California suggests that Nitrate may be applied to better advantage just as soon as growth starts in the Spring, or better, before seeding or planting.

When Nitrate is applied at the rate of two hundred (200) pounds per acre for cultivated crops and used alone this application figures out at the rate of 8 oz. for a plot 10x10. This application is equivalent to about 1 oz. to the square yard.

So many inquiries have been made requesting amounts to be applied to small areas that the above word is given in this connection.

America Spends $175,000,000 a Year for Fertilizer.

By Richard Spillane

It is estimated that the American farmer pays in excess of $175,000,000 a year for fertilizer. If he mixed a little brains with his fertilizer he would get better results. He is improving in his methods, but it will be a long, long time before he overtakes the European agriculturist, particularly the German.

One of the indictments against the American people is that, with the greatest natural advantages of any inhabitants of the earth's surface, they make a shockingly bad showing in comparison with their less favored brothers.

For example: In Europe, where the land has been tilled for centuries upon centuries, the average yield per acre of the great crops is approximately double that of the United States. The European wheat crop averages 33 bushels per acre; oats, 45 bushels per acre, and potatoes, nearly 200 bushels per acre. In the United States the yield averages: Wheat, 14 bushels per acre; oats, 40 bushels per acre, and potatoes, a trifle more than 97 bushels per acre.

Broadly speaking, the foreign farmer studies his soil; the American farmer does not. It has been said of the American farmer that he is one of the greatest slovens on earth. This may be rather a harsh judgment, but certainly he merits sharp criticism. It is not the grower of wheat, or oats, or corn, or potatoes alone who neglects his opportunities. The cotton planter is as bad a sinner as his northern fellow. The average yield of cotton per acre in the United States is 185 pounds. In Egypt the average yield per acre is 400 pounds. There is not any more doubt that the yield per acre in the United States could be brought up to 400 pounds an acre than that the sun is going to continue to shine.

Europe started half a century before America to nourish the land scientifically. The farmers there, having studied the subject, now know how to treat the land intelligently. In the United States there is a vast area that has not known the need of fertilizer, but in the older States, the ones along the Atlantic, where the land has been in cultivation 100 or more years the soil has been worn out and needs reinforcing or it is practically valueless for crops.

Unfortunately for the United States, a large number of the farmers, neither knowing the needs of their lands, nor the properties that go to make the best fertilizer, think any kind of fertilizer will do. They buy blindly and let it go at that. As a general thing they are actuated by the price. Good fertilizers are costly. The cheap may do just as good, they reason.

Sick or worn-out land needs as careful treatment as an ill or worn-out human. To cheat the land is not good business, and does not bring good results. You cannot fool nature.

No fertilizer is of much account unless it contains the three great essentials—nitrogen, phosphoric acid and potash. When all are present the fertilizer is said to be complete. When they are not, the fertilizer is incomplete, lacking in energy, and the result from its use is not satisfactory.

The materials that furnish nitrogen are Nitrate of Soda, nitrate of lime, sulphate of ammonia, calcium cyanamid, dried blood, tankage, fish scrap, cotton seed meal, horn and hoof meal, hair and wool and leather scrap.

The materials that furnish phosphoric acid are Thomas slag, acid phosphate, bone meal, phosphoric guano, fish scrap and bone tankage.

The materials furnishing potash are potash salts and unleached wood ashes.

A pure fertilizer law is needed as much as a pure food law. The development of agriculture in the United States is retarded by the use of inferior fertilizer.

Evidently the American tendency to palm off "something just as good" has been in evidence in the fertilizer trade.

At a luncheon given in Chicago on January 9, 1914, by a committee of the National Fertilizer Association, one speaker, evidently desirous of spreading the use of fertilizer in the West, had this to say:

"James J. Hill has conducted some wonder-working experiments with fertilizers, which have not received the attention they deserve in the West. Is it because the West does not want to admit that it needs rejuvenation, or is it because she is complacent? Hill showed in one season, by the use of fertilizers, that he could double the yield of cereals in the Middle Northwest. It matters not at this time whether it was done at a profit. The important thing is to demonstrate that yields can be doubled by a certain treatment.

"The value of commercial plant food has passed beyond the experimental stage in Europe and in the eastern part of this country. Why not accept the testimony of seventy-five years at Rothamsted, of fifty years at Halle, and of thirty years in Georgia and in Maine. I sometimes wonder if the agricultural teachers and writers in the West are not standing in the way of agricultural progress by still considering as an academic question the value and need of fertilizers. The question is not—Are commercial fertilizers good and useful?—but will it pay to use them as James J. Hill has done in his part of the country. To my mind, Mr. Hill has answered the question, "Will it pay?" in the affirmative. By the use of a little over $5 worth of fertilizer per acre he practically doubled the yield of wheat, oats and barley, and you can figure whether it paid or not. I wish that other railway officials might follow his splendid example."

No agriculturist needs knowledge of the soil more than the cotton grower. Those figures showing that Egypt—old, backward Egypt—is far in advance of him in cotton raising should stir him, if the loss he is suffering financially did not.

When he knows more about fertilizers he will raise larger crops. Quantity is less important than quality in what is supplied toward energizing land.

Considering the fact that of the more than $175,000,000 spent for fertilizer, the farmer of the South pays out fully one-half, he should not be satisfied with the result.

Analyses of Commercial Fertilizing Materials.

Name of Substance.	Moisture.	Nitrogen.	Potash.	Phosphoric Acid.		
				Available.	Insoluble.	Total.
I. Phosphatic Manures—						
Apatite	....	....	....	....	....	36.08
Bone-ash	7.00	....	....	...	....	35.89
Bone-black	4.60	....	....	....	....	28.28
Bone-black (dissolved)	....	....	....	16.70	0.30	17.00
Bone meal	7.47	4.12	....	8.28	15.22	23.50
Bone meal (free from fats)	....	6.20	....	....	....	20.10
Bone meal (from glue factory)	....	1.70	....	....	....	29.90
Bone meal (dissolved)	....	2.60	....	13.53	4.07	17.60
S. Carolina rock (ground)	1.50	....	....	0.60	27.43	28.03
S. Carolina rock (floats)	....	....	....	....	....	27.20
S. Carolina rock (dissolved)	....	....	....	11.60	3.60	15.20
II. Potash Manures.						
Carnallite	....	....	13.68	....	....	....
Cotton-seed hull ashes	7.33	....	23.80	....	....	8.50
Kainit	3.20	....	13.54	....	....	....
Krugite	4.82	....	8.42	....	....	....
Muriate of potash	2.00	....	52.46	....	....	....
Nitrate of potash	1.93	13.09	45.19	....	....	....
Spent tan-bark ashes	6.31	....	2.04	....	....	1.61
Sulph. potash (high grade)	1.25	....	38.60	....	....	....
Sulph. potash and magnesia	4.75	....	23.50	....	....	....
Sylvinite	7.25	....	16.65	....	....	....
Waste from gunpowder works	2.75	2.43	18.00	....	....	....
Wood-ashes (unleached)	12.00	....	5.50	....	....	1.85
Wood-ashes (leached)	....	....	1.10	....	....	1.40
III. Nitrogenous Manures.						
Castor pomace	9.98	5.56	1.12	....	....	2.16
Cotton-seed meal	6.80	6.66	1.62	....	....	1.45
Dried blood	12.50	10.52	....	....	....	1.91
Dried fish	12.75	7.25	0.45	3.05	5.20	8.25
Horn and hoof waste	10.17	13.25	....	....	....	1.83
Lobster shells	7.27	4.50	....	....	....	3.52
Meat scrap	12.09	10.44	....	....	....	2.07

Analyses of Commercial Fertilizing Materials.

Continued.

Name of Substance.	Moisture.	Nitrogen.	Potash.	Phosphoric Acid.		
				Available.	Insoluble.	Total.
III. Nitrogenous Manures—Continued.						
Malt Sprouts	7.40	4.04	2.20	....	....	1.70
Nitrate of Soda	1.25	15.65	....	....	....	....
Nitre-cake	6.00	2.30	0.40	....	....	....
Oleomargarine refuse	8.54	12.12	....	....	....	0.88
Sulphate of ammonia	1.00	20.50	....	....	....	....
Tankage	13.20	6.82	....	5.02	6.23	11.25
Tobacco stems	10.61	2.29	6.44	....	....	0.60
Wool waste	9.27	5.64	1.30	....	....	0.29
IV. Miscellaneous Materials.						
Ashes (anthracite coal)	....	....	0.10	....	....	0.10
Ashes (bituminous coal)	....	....	0.40	....	....	0.40
Ashes (corn-cob)	....	....	23.20	....	....	....
Ashes (lime-kiln)	15.45	....	0.86	....	....	1.18
Ashes (peat and bog)	5.20	....	0.70	....	....	0.50
Gas lime	4.40	0.30	....	....	....	....
Marls (Maryland)	1.73	....	1.25	....	....	0.38
Marls (Massachusetts)	18.18	....	....	....	....	1.05
Marls (North Carolina)	1.50	....	0.04	....	....	0.56
Marls (Virginia)	15.98	....	0.49	....	....	0.09
Muck (fresh)	76.20	0.30	....	....	....	....
Muck (air-dry)	21.40	1.30	....	....	....	....
Mud (fresh water)	40.37	1.37	0.22	....	....	0.26
Mud (from sea-meadows)	53.50	0.20	0.20	....	....	0.10
Peat	61.50	0.75	....	....	....	....
Pine straw (dead leaves or pine needles)	7.80	0.30	0.10	....	....	0.20
Shells (mollusks)	....	0.10	0.04	....	....	0.03
Shells (crustacea)	....	6.20	0.20	....	....	2.30
Shell lime (oyster shell)	19.50	....	0.04	....	....	0.20
Soot	5.54	....	1.83	....	....	....
Spent tan	14.00	0.20	0.10	....	....	0.04
Spent sumach	30.80	1.00	0.30	....	....	0.10
Sugar-house scum	50.20	2.10	....	....	....	....
Turf	19.29	1.94	....	....	....	....

Analyses of Farm Manures.

TAKEN CHIEFLY FROM REPORTS OF THE NEW YORK, MASSACHUSETTS AND CONNECTICUT EXPERIMENT STATIONS.

Name of Substance.	Moisture.	Nitrogen.	Potash.	Phosphoric Acid.
I.				
Cattle (solid fresh excrement)	....	0.29	0.10	0.17
Cattle (fresh urine)........	....	0.58	0.49	....
Hen manure (fresh).......	....	1.63	0.85	1.54
Horse (solid fresh excrement)	....	0.44	0.35	0.17
Horse (fresh urine)........	....	1.55	1.50	....
Human excrement (solid)..	77.20	1.00	0.25	1.09
Human urine.............	95.90	0.60	0.20	0.17
Poudrette (night soil)......	....	0.80	0.30	1.40
Sheep (solid fresh excrement)	....	0.55	0.15	0.31
Sheep (fresh urine)........	....	1.95	2.26	0.01
Stable manure (mixed).....	73.27	0.50	0.60	0.30
Swine (solid fresh excrement)	....	0.60	0.13	0.41
Swine (fresh urine)........	....	0.43	0.83	0.07

Analyses of Fertilizing Materials in Farm Products.

ANALYSES OF HAY AND DRY COARSE FODDERS.

Name of Substance.	Moisture.	Nitrogen.	Potash.	Phosphoric Acid.
II. Hay and Dry Coarse Fodders.				
Blue melilot..............	8.22	1.92	2.80	0.54
Buttercups...............	....	1.02	0.81	0.41
Carrot tops (dry)..........	9.76	3.13	4.88	0.61
Clover (alsike)............	9.93	2.33	2.01	0.70
Clover (Bokhara)..........	6.36	1.77	1.67	0.44
Clover (mammoth red)....	11.41	2.23	1.22	0.55
Clover (medium red)......	10.72	2.09	2.20	0.44
Clover (white)............	....	2.75	1.81	0.52
Corn fodder..............	....	1.80	0.76	0.51
Corn stover..............	28.24	1.12	1.32	0.30
Cow-pea vines............	9.00	1.64	0.91	0.53
Daisy (white)............	9.65	0.28	1.25	0.44
Daisy (ox-eye)............	....	0.80	2.23	0.27
Hungarian grass..........	7.15	1.16	1.28	0.35
Italian rye-grass..........	8.29	1.15	0.99	0.55
June grass................	....	1.05	1.46	0.37
Lucern (alfalfa)...........	6.26	2.07	1.46	0.53

Analyses of Fertilizing Materials in Farm Products.

Continued.

Name of Substance.	Moisture.	Nitrogen.	Potash.	Phosphoric Acid.
II. Hay and Dry Coarse Fodders—Continued.				
Meadow fescue	9.79	0.94	2.01	0.34
Meadow foxtail	....	1.54	2.19	0.44
Mixed grasses	11.26	1.37	1.54	0.35
Orchard grass	8.84	1.31	1.88	0.41
Perennial rye-grass	9.13	1.23	1.55	0.56
Red-top	7.71	1.15	1.02	0.36
Rowen	12.48	1.75	1.97	0.46
Salt hay	5.36	1.18	0.72	0.25
Serradella	7.39	2.70	0.65	0.78
Soja bean	6.30	2.32	1.08	0.67
Tall meadow oat	....	1.16	1.72	0.32
Timothy hay	7.52	1.26	1.53	0.46
Vetch and oats	11.98	1.37	0.90	0.53
Yellow trefoil	....	2.14	0.98	0.43
III. Green Fodders.				
Buckwheat	82.60	0.51	0.43	0.11
Clover (red)	80.00	0.53	0.46	0.13
Clover (white)	81.00	0.56	0.24	0.20
Corn fodder	72.64	0.56	0.62	0.28
Corn fodder (ensilage)	71.60	0.36	0.33	0.14
Cow-pea vines	78.81	0.27	0.31	0.98
Horse bean	74.71	0.68	1.37	0.33
Lucern (alfalfa)	75.30	0.72	0.45	0.15
Meadow grass (in flower)	70.00	0.44	0.60	0.15
Millet	62.58	0.61	0.41	0.19
Oats (green)	83.36	0.49	0.38	0.13
Peas	81.50	0.50	0.56	0.18
Prickly comfrey	....	0.42	0.75	0.11
Rye grass	70.00	0.57	0.53	0.17
Serradella	82.59	0.41	0.42	0.14
Sorghum	....	0.40	0.32	0.08
Spanish moss	60.80	0.28	0.26	0.30
Vetch and oats	86.11	0.24	0.79	0.09
White lupine	85.35	0.44	1.73	0.35
Young grass	80.00	0.50	1.16	0.22
IV. Straw, Chaff, Leaves, etc.				
Barley chaff	13.08	1.01	0.99	0.27
Barley straw	13.25	0.72	1.16	0.15
Bean shells	18.50	1.48	1.38	0.55

Analyses of Fertilizing Materials in Farm Products.

Continued.

Name of Substance.	Moisture.	Nitrogen.	Potash.	Phosphoric Acid.
IV. Straw, Chaff, Leaves, etc.—Continued.				
Beech leaves (autumn).....	15.00	0.80	0.30	0.24
Buckwheat straw..........	16.00	1.30	2.41	0.61
Cabbage leaves (air-dried).	14.60	0.24	1.71	0.75
Cabbage stalks (air-dried).	16.80	0.18	3.49	1.06
Carrots (stalks and leaves).	80.80	0.51	0.37	0.21
Corn cobs................	12.09	0.50	0.60	0.06
Corn hulls................	11.50	0.23	0.24	0.02
Hops.....................	11.07	2.53	1.99	1.75
Oak leaves...............	15.00	0.80	0.15	0.34
Oat chaff.................	14.30	0.64	1.04	0.20
Oat straw................	28.70	0.29	0.88	0.11
Pea shells................	16.65	1.36	1.38	0.55
Pea straw (cut in bloom)..	....	2.29	2.32	0.68
Pea straw (ripe)..........	....	1.04	1.01	0.35
Potato stalks and leaves...	77.00	0.49	0.07	0.06
Rye straw................	15.40	0.24	0.76	0.19
Sugar-beet stalks and leaves	92.65	0.35	0.16	0.07
Turnip stalks and leaves...	89.80	0.30	0.24	0.13
Wheat chaff (spring).......	14.80	0.91	0.42	0.25
Wheat chaff (winter)......	10.56	1.01	0.14	0.19
Wheat straw (spring)......	15.00	0.54	0.44	0.18
Wheat straw (winter)......	10.36	0.82	0.32	0.11
V. Roots, Tubers, etc.				
Beets (red)...............	87.73	0.24	0.44	0.09
Beets (sugar).............	84.65	0.25	0.29	0.08
Beets (yellow fodder)......	90.60	0.19	0.46	0.09
Carrots..................	90.02	0.14	0.54	0.10
Mangolds.................	87.29	0.19	0.38	0.09
Potatoes.................	79.75	0.21	0.29	0.07
Ruta bagas...............	87.82	0.21	0.50	0.13
Turnips..................	87.20	0.22	0.41	0.12
VI. Grains and Seeds.				
Barley...................	15.42	2.06	0.73	0.95
Beans....................	....	4.10	1.20	1.16
Buckwheat................	14.10	1.44	0.21	0.44
Corn kernels..............	10.88	1.82	0.40	0.70
Corn kernels and cobs (cob meal)..................	10.00	1.46	0.44	0.60
Hemp seed...............	12.20	2.62	0.97	1.75
Linseed..................	11.80	3.20	1.04	1.30
Lupines..................	13.80	5.52	1.14	0.87

Analyses of Fertilizing Materials in Farm Products.

Continued.

Name of Substance.	Moisture.	Nitrogen.	Potash.	Phosphoric Acid.
VI. Grains and Seeds—Continued.				
Millet	13.00	2.40	0.47	0.91
Oats	20.80	1.75	0.41	0.48
Peas	19.10	4.26	1.23	1.26
Rye	14.90	1.76	0.54	0.82
Soja beans	18.83	5.30	1.99	1.87
Sorghum	14.00	1.48	0.42	0.81
Wheat (spring)	14.75	2.36	0.61	0.89
Wheat (winter)	15.40	2.83	0.50	0.68
VII. Flour and Meal.				
Corn meal	13.52	2.05	0.44	0.71
Ground barley	13.43	1.55	0.34	0.66
Hominy feed	8.93	1.63	0.49	0.98
Pea meal	8.85	3.08	0.99	0.82
Rye flour	14.20	1.68	0.65	0.85
Wheat flour	9.83	2.21	0.54	0.57
VIII. By-products and Refuse.				
Apple pomace	80.50	0.23	0.13	0.02
Cotton hulls	10.63	0.75	1.08	0.18
Cotton-seed meal	....	6.52	1.89	2.78
Glucose refuse	8.10	2.62	0.15	0.29
Gluten meal	8.53	5.43	0.05	0.43
Hop refuse	8.98	0.98	0.11	0.20
Linseed cake (new process)	6.12	5.40	1.16	1.42
Linseed cake (old process)	7.79	6.02	1.16	1.65
Malt sprouts	10.28	3.67	1.60	1.40
Oat bran	8.19	2.25	0.66	1.11
Rye middlings	12.54	1.84	0.81	1.26
Spent brewers' grains (dry)	6.98	3.05	1.55	1.26
Spent brewers' grains (wet)	75.01	0.89	0.05	0.31
Wheat bran	11.01	2.88	1.62	2.87
Wheat middlings	9.18	2.63	0.63	0.95
IX. Dairy Products.				
Milk	87.20	0.58	0.17	0.30
Cream	68.80	0.58	0.09	0.15
Skim-milk	90.20	0.58	0.19	0.34
Butter	13.60	0.12	....	....
Butter-milk	90.10	0.64	0.09	0.15
Cheese (from unskimmed milk)	38.00	4.05	0.29	0.80
Cheese (from half-skimmed milk)	39.80	4.75	0.29	0.80
Cheese (from skimmed milk)	46.00	5.45	0.20	0.80

Analyses of Fertilizing Materials in Farm Products.
Continued.

Name of Substance.	Moisture.	Nitrogen.	Potash.	Phosphoric Acid.
X. Flesh of Farm Animals.				
Beef	77.00	3.60	0.52	0.43
Calf (whole animal)	66.20	2.50	0.24	1.38
Ox	59.70	2.66	0.17	1.86
Pig	52.80	2.00	0.90	0.44
Sheep	59.10	2.24	0.15	1.23
XI. Garden Products.				
Asparagus	....	0.32	0.12	0.09
Cabbage	....	0.30	0.43	0.11
Cucumbers	....	0.16	0.24	0.12
Lettuce	....	0.20	0.25	0.11
Onions	....	0.27	0.25	0.13

Table Showing the Number of Pounds of Nitrogen, Phosphoric Acid, and Potash Withdrawn Per Acre by an Average Crop.

(From New York, New Jersey and Connecticut Experiment Stations' Reports.)

Name of Crop.	Nitrogen.	Phosphoric Acid.	Potash.
Barley	78	35	62
Buckwheat	63	40	17
Cabbage (white)	213	125	514
Cauliflower	202	76	265
Cattle turnips	187	74	426
Carrots	166	65	190
Clover, green (trifolium pratense)	171	46	154
Clover (trifolium pratense)	37	18	29
Clover, scarlet (trifolium incarnatum)	95	17	57
Clover (trifolium repens)	89	29	58
Cow pea	254	64	169
Corn	146	69	174
Corn fodder (green)	122	66	236
Cotton	110	32	35
Cucumbers	142	94	193
Esparsette	239	36	103
Hops	200	54	127
Hemp	...	34	54
Lettuce	41	17	72
Lucern	289	65	181
Lupine, green (for fodder)	219	46	63
Lupine, yellow (lupinus luteus)	80	37	155
Meadow hay	166	53	201

Table Showing the Number of Pounds of Nitrogen, Phosphoric Acid, and Potash Withdrawn Per Acre by an Average Crop.

Continued.

Name of Crop.	Nitrogen.	Phosphoric Acid.	Potash.
Oats	89	35	96
Onions	96	49	96
Peas (pisuni sativum	153	39	69
Poppy	87	30	87
Potatoes	119	55	192
Rape	154	79	124
Rice	39	24	45
Rye	87	44	76
Seradella	128	57	196
Soja bean	297	62	87
Sugar cane	518	37	107
Sorghum (sorghum saccharatum)	446	90	561
Sugar beet (beet-ro t)	95	44	200
Tobacco	127	32	148
Vetch (visia sativa)	149	35	113
Wheat	111	45	58

Fertilizer Experiments on Meadow Land.

(Kentucky Agricultural Experiment Station Bulletin, No. 23, February, 1890.)

On low and decidedly wet land.

English Blue Grass.

Fertilizers Used Per Acre.	Amount Per Acre in Pounds.	Yield of Hay in Pounds Per Acre.
Sulphate of potash	160	3,000
Muriate of potash	160	2,950
Nitrate of Soda	160	3,100
Sulphate of ammonia	130	3,600
No fertilizer	...	2,850
Stable manure	20 loads	2,970
Tobacco stems	4,000	4,700

Fertilizer Experiments on Meadow Land.—*Continued.*

Timothy.

Kind of Fertilizer Used.	Amount Per Acre in Pounds.	Yield of Hay in Pounds Per Acre.
Sulphate of potash	160	1,900
Muriate of potash	160	2,320
Nitrate of Soda	160	2,670
Sulphate of ammonia	130	2,520
No fertilizer	...	1,620
Stable manure	20 loads	2,200
Tobacco stems	4,000	3,350

Time Required for the Complete Exhaustion of Available Fertilizing Materials and the Amounts of Each Remaining in the Soil During a Period of Seven Years.

(From Scottish Estimates.)

ON UNCULTIVATED CLAY LOAM.

Kind of Fertilizer.	Exhausted (in years).	Per cent. remaining in the soil unexhausted at the end of each year.						
		1	*2*	*3*	*4*	*5*	*6*	*7*
Lime	12	80	65	55	45	35	25	20
Bone meal	5	60	30	20	10	00	00	00
Phosphatic guanos	5	50	30	20	10	00	00	00
Dissolved bones and plain superphosphates	4	20	10	5	00	00	00	00
High grade ammoniated fertilizers, guano, etc	3	30	20	00	00	00	00	00
Cotton-seed meal	5	40	30	20	10	00	00	00
Barn-yard manure	5	60	30	20	10	00	00	00

ON UNCULTIVATED LIGHT OR MEDIUM SOILS.

Lime	10	75	60	40	30	20	15	..
Bone meal	4	60	30	10	00	00	00	..
Phosphatic guanos	4	50	20	10	00	00	00	..
Dissolved bones and plain superphosphates	3	20	10	5	00	00	00	00
High grade ammoniates, guanos	3	30	20	00	00	00	00	00
Cotton-seed meal	4	40	30	20	10	00	00	00
Barn-yard manure	4	60	30	10	00	00	00	00

ON UNCULTIVATED PASTURE LAND.

Kind of Fertilizer.	Exhausted	Per cent. remaining in the soil unexhausted at the end of each year,						
		1	*2*	*3*	*4*	*5*	*6*	*7*
Lime	15	80	70	60	50	45	40	35
Bone meal	7	60	50	40	30	20	10	00
Phosphatic guano	6	50	40	30	20	10	00	80
Dissolved bone, etc	4	30	20	10	00	00	00	00
High grade ammoniated guanos	4	30	20	10	00	00	00	00
Cotton-seed meal	5	40	30	20	10	00	00	00
Barn-yard manure	7	60	50	40	30	20	10	00

The figures given above are always used in fixing the price for new tenants. In this country no such careful estimates have been made, but the proportions probably vary but little from those in other countries.

Amounts of Nitrogen, Phosphoric Acid, and Potash Found Profitable for Different Crops Under Average Conditions Per Acre.

(Taken Chiefly from New Jersey Experiment Station's Reports.)

	Nitrogen, Pounds.	Phosphoric Acid, Pounds.	Potash. Pounds.
Wheat, rye, oats, corn	16	40	30
Potatoes and root crops	20	25	40
Clover, beans, peas and other leguminous crops	..	40	60
Fruit trees and small fruits	25	40	75
General garden produce	30	40	60

Rotation in Crops.

In the changed conditions of agriculture elaborate systems of crop rotation are no longer necessary. With the help of chemical manures and the judicious use of renovating crops farmers are no longer subject to rigid rule, but may adapt rotations to the varying demands of local market conditions.

Some American Rotations.

1. Potatoes.	1. Potatoes.
2. Wheat.	2. Wheat.
3. Clover.	3. Grass, timothy and clover.
4. Clover.	4. Grass, timothy and clover.
5. Wheat, oats or rye.	5. Corn.

1. Roots.	1. Roots.
2. Wheat.	2. Wheat.
3. Clover.	3. Clover.
4. Clover.	4. Clover.
5. Corn, oats or rye.	5. Wheat.
	6. Oats.

RESULTS IN NEW YORK.

The general practice among farmers is to buy complete medium or low-grade fertilizers in preference to high-grade fertilizers. In high-grade goods, the cost of plant-food is considerably less than in fertilizers of lower grade.

Available phosphoric acid is cheapest in the form of dissolved rock (acid phosphate). Bone-meal furnishes a cheap source of phosphoric acid in less available form. Nitrate of Soda is one of the cheapest sources of Nitrogen. Nitrogen in the form of dried blood is rather high. Potash in the form of muriate is the cheapest source of potash. In mixtures of fertilizing materials, whether complete or incomplete, the plant-food usually costs more than in unmixed materials.

When purchasing mixed fertilizers, farmers are advised to purchase only high-grade goods, and then to make a commercial valuation to compare with the selling price. Even in high-grade goods, the selling price should not exceed the commercial valuation by more than $5.

For greatest economy, farmers are advised to purchase unmixed materials and do their own mixing; or, in the case of clubs, several farmers can purchase their unmixed materials and hire a fertilizer manufacturer to do the mixing for them.

The following data, taken from the last U. S. Census Report, are of interest in this connection as indicating in what portion of the State the largest amount of money is expended for commercial fertilizers:

Long Island (Counties of Nassau, Queens and Suffolk)	$1,241,280
Monroe County	214,000
Erie County	186,370
Cayuga County	131,260
Oneida County	112,630
Onondaga, Ontario, Wayne, Ulster, Chautauqua, each from $102,000 to	110,000

These twelve counties use about one-half of the commercial fertilizers used in the entire State.

Composition of Fertilizers in Different Classes.

If we compare our four different classes of complete fertilizers in respect to the average amounts of Nitrogen, available phosphoric acid and potash contained in them, we have the following table:

Composition of Different Grades of Fertilizers.

Class of Fertilizers.	In 100 Pounds of Fertilizer.			
	Pounds of Nitrogen.	Pounds of Available Phosphoric Acid.	Pounds of Potash.	Pounds of Total Plant-food.
Low-grade	1.22	8.18	2.60	12.00
Medium-grade	1.70	9.10	3.48	14.28
Medium high-grade	2.47	8.82	6.02	17.37
High-grade	4.00	8.36	7.22	19.60

In the fourth column, under the heading "pounds of total plant-food," we give the sum of the Nitrogen, available phosphoric acid and potash. We notice the following points in connection with this table:

1. The percentage of phosphoric acid does not vary greatly in the different classes of fertilizers.
2. The percentage of Nitrogen and of potash increases in the higher grades.
3. The total amount of plant-food in 100 pounds of fertilizer increases in the higher grades, this increase being due to increase of Nitrogen and potash.

4. Representing the amount of Nitrogen in each grade of fertilizer as 1, we have the following proportions of available phosphoric acid and potash in the different grades:

Composition of Different Grades of Fertilizers.

	Nitrogen.	Available Phosphoric Acid.	Potash.
Low-grade....................	1	7	2
Medium-grade.................	1	5.5	2
Medium high-grade	1	3.5	2.5
High-grade...................	1	2	1.8

Cost of One Pound of Plant-Food in Different Grades of Fertilizers.

	Low-Grade.	Medium-Grade.	Medium High-Grade.	High-Grade.
Cost of one pound of Nitrogen	*Cents.*	*Cents.*	*Cents.*	*Cents.*
Lowest..................	20	17.9	17	13.3
Highest.................	36.8	28.3	26	26.0
Average.................	26.3	23.2	21	19.6
Cost of one pound of Available Phosphoric Acid.				
Lowest..................	6.1	5.4	5.1	4.25
Highest.................	11.1	8.6	8.1	7.9
Average.................	8.0	7.0	6.4	6.0
Cost of one pound of Potash.				
Lowest..................	5.2	4.6	4.4	3.4
Highest.................	9.5	7.3	6.9	6.7
Average.................	6.8	6.0	5.4	5.0

From these data, we readily see the truth of the following statements:

1. The cost of one pound of plant-food, whether Nitrogen, phosphoric acid or potash, is greatest in low-grade and least in high-grade fertilizers. One purchaser of low-grade goods paid 36.8 cents per pound for Nitrogen, while the highest price paid in high-grade

goods was 26 cents, which is less than the average paid for Nitrogen in low-grade goods. The least amount paid for one pound of Nitrogen in low-grade goods was 20 cents, in high-grade goods 13.3 cents. Similar relations hold good in respect to the other elements of plant-food.

2. In general, the higher the grade of goods, the lower the cost of each pound of plant-food.

Tabulated General Summary.

In the table following, we give a general summary of the data that have been presented, showing the cost of one pound of plant-food in different forms to consumers:

Cost of One Pound of Plant-Food to Consumers.

	Lowest.	Highest	Average.
NITROGEN IN	*Cents.*	*Cents.*	*Cents.*
Low-grade complete fertilizers	20	36.8	26.3
Medium-grade complete fertilizers	17.9	28.3	23.2
Medium high-grade complete fertilizers	17	26	21
High-grade complete fertilizers	13.3	26	19.6
Dried blood	14.8	22.9	18.5
Bone-meal	11.5	32	14.9
Nitrate of Soda	13	15	13.9
PHOSPHORIC ACID IN			
Low-grade complete fertilizers	6.1	11.1	8.0
Medium-grade complete fertilizers	5.4	8.6	7.0
Medium high-grade complete fertilizers	5.1	8.1	6.4
High-grade complete fertilizers	4.25	7.9	6.0
Phosphoric acid and potash mixtures	4.3	19.5	8.6
Acid phosphate or dissolved rock	4.4	11.0	5.1
Bone (total)	3.1	8.6	3.96
POTASH IN			
Low-grade complete fertilizers	5.2	9.5	6.8
Medium-grade complete fertilizers	4.6	7.3	6.0
Medium high-grade complete fertilizers	4.4	6.9	5.4
High-grade complete fertilizers	3.4	6.7	5.0
Phosphoric acid and potash mixtures	3.7	16.5	5.6
Muriate of potash	4.4	4.9	4.6

Plants can take up Nitrogen only in the form of Nitrates—that is, in combination with alkaline base, such as lime or sodium.

The Nitrogen contained in all fertilizers, with the exception of Nitrate of Soda, must first be nitrified—that is, converted into Nitrate—before the plant can take it up. This nitrification is always attended with greater or less loss of Nitrogen.

A sufficiency of lime in the soil hastens nitrification, while a scarcity of lime retards it. Nitrate of Soda is the only nitrogenous fertilizer that will do its work perfectly without lime, because it already contains Nitrogen in a form that is capable of absorption by plants.

Leguminous plants assimilate free Nitrogen from the air through the medium of the micro-organisms inhabiting the nodules found in their roots. Leguminous plants, in the early stages of their growth, avail themselves of the Nitrates in the soil. *Nitrate of Soda* has been very profitably used in the cultivation of Lucern, or "Alfalfa," etc.

Crops that have suffered from wintering, from insects, etc., can, in most cases, be considerably improved by top-dressing with *Nitrate of Soda.*

When the soil is very poor in potash, the soda contained in *Nitrate of Soda* will, to a certain extent, serve as a substitute for potash. It is not, however, a perfect substitute. Poverty in potash can be fully made good only by applying a sufficient quantity of a potash fertilizer.

Nitrate of Soda is easily soluble, and it distributes itself immediately through the soil.

Distribution of Nitrogen in the Grain and Straw of the Principal Cereals.

Nitrogen per Two and One-Half Acres.

GRAIN.

Oats, 82.42 lbs.	Barley, 86.61 lbs.	Wheat, 81.10 lbs.	Rye, 67.44 lbs.
Rape Seed, 176.32 lbs.	Peas, 117.03 lbs.	Vetches, 143.92 lbs.	Broad Beans, 181.16 lbs.

STRAW.

Oats, 26.4 lbs.	Barley, 26.4 lbs.	Wheat, 33.06 lbs.	Rye, 29.31 lbs.
Rape Seed, 29.75 lbs.	Peas, 118.35 lbs.	Vetches, 112.40 lbs.	Broad Beans, 79.34 lbs.

Distribution of Nitrogen in the Principal Root Crops.

NITROGEN PER TWO AND ONE-HALF ACRES.

ROOTS.

Sugarbeet, 105.79 lbs.	Beetroot, 138.85 lbs.	Swedes, 165.30 lbs.	Carrots, 145.46 lbs.	Potatoes, 112.40 lbs.
			TUBERS.	

LEAF.

Sugarbeet, 52.89 lbs.	Beetroot, 80.66 lbs.	Swedes, 55.1 lbs.	Carrots, 168.60 lbs.	Potatoes, 15.11 lbs.
			SHAWS.	

The figures in this table show how many pounds of Nitrogen are withdrawn from two and one-half acres of ground.

Thus in the low grade "complete fertilizers" the consumer pays more for his Nitrogen than he pays for it in Nitrate of Soda at One Hundred Dollars ($100.00) per ton!!!

In the medium grade "complete fertilizers" he pays more than he would pay for it in Nitrate of Soda at Eighty Dollars ($80.00) per ton!!

In the high grade "complete fertilizers" he pays as much for it as he would pay for it in Nitrate of Soda at Seventy-One Dollars ($71.00) per ton!

Besides which, since one must buy nearly Twenty Tons of low grade fertilizer to get a ton of Nitrate of Soda, **or anything like its equivalent,** there is a material saving in freight which may amount to 95 per cent. of the cost. Instead of transporting twenty tons of more or less inert material you need only to pay the freight charges on one ton of concentrated plant food—that is: substance instead of shadow.

Since Nitrate of Soda is the one immediately available Nitrogenous plant food, and costs less per pound for the available Nitrogen it contains, than any other Nitrogenous fertilizer, its rational use is most profitable at present, and has been so since the very beginning of its use in agriculture.

What Experiment Station Directors Say:

"I can safely state that there are a large number of farmers in New Jersey who mix their fertilizers and who find home-mixed material very satisfactory and less costly than the manufactured products."—JACOB B. LIPMAN, Director New Jersey Agric. Exp't. Station.

"We advocate home mixing of fertilizers mainly from the fact that we can modify the fertilizers to suit the crop and the soil, and can avoid the purchase of elements not required for ordinary purposes."—W. R. DODSON, Dean and Director, La. State University College of Agriculture and Agric. Exp't. Station.

"We practice and preach that farmers should mix their own fertilizers. In our experience, it is entirely practical for the farmer to mix his own fertilizer. The work can be done thoroughly enough for all practical purposes."—H. J. PATTERSON, Director Maryland Agric. Exp't. Station.

"This Station has for the past ten years advised farmers to buy high grade raw materials and mix their fertilizers at home. The home mixing cheapens the cost of fertilizers since only such elements as are needed by the plant or are deficient in the soil are used. Practically all of our most intelligent farmers mix their fertilizers at home."—E. R. LLOYD, Director Mississippi Agric. Exp't. Station.

"We find that as a farm proposition, home-mixed fertilizers are more economical and more effective than the regular factory brands."—CHAS. E. THORNE, Director Ohio Agric. Exp't. Station.

"On every account, however, financial, educational, agricultural, it is better to buy the crude stock and home mix if one uses a ton or more."—J. L. HILLS, Director Vermont Agric. Exp't. Station.

We could give many additional recommendations of home-mixing, but it will suffice to state that of 37 Stations heard from, 35 advocate this practice.

Frequently fertilizers mixed in the factories, upon being analyzed, show a considerable variation and the claim of "uniform mixed" is not a valid one. In order to secure uniform mixture it is just as necessary to observe care in the factory as on the farm.

The claim made by fertilizer manufacturers that they only enjoy a monopoly of the custom and habit of being careful and painstaking in their work is not justified by the facts. Frequent practical trials of home mixing by farmers show variations of less than two-tenths of one per cent. as between calculated and actual percentages found by analysis.

Moreover, the composition of ready-mixed fertilizers varies with the opinion of the manufacturer. For example: In New Jersey there have been over fifty different fertilizers for potatoes offered as being precisely the thing for the potato crop, yet varying widely in their percentage composition.

Bulletin No. 173 of the Alabama Experiment Station states that Nitrate of Soda is the most effective source of nitrogen for oats and that it should be applied as a top dressing in March for that crop.

When gold ore is sent to an assay office to be analyzed the sender wishes to have the number of ounces of gold per ton determined; in other words he wants to know the percentage of gold in the ore.

In buying a fertilizer the user ought similarly to know the percentage of nitrogen (which is the gold of the fertilizer), for it is worth five times more in the open market than any other constituent that the fertilizer may contain. When you buy your fertilizer, therefore, why not inform yourself of this very vital gold point.

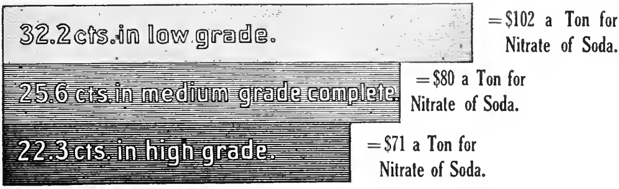
You can make as much money by careful purchasing of supplies for your farm as you can in wise marketing of what you produce. Insist on knowing values and the nature and quality of the Nitrogen in your goods, which is worth more than anything else in the open market to you personally for use on your land.

FERTILIZERS.

After the original Chart arranged by Director J. L. Hills, of the Vermont Experiment Station, for the U. S. Government Fertilizer Exhibit at the St. Louis Exposition.

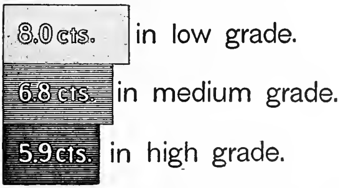
Average cost of a pound of plant food in "low," "medium" and "high" grade "complete fertilizers" (Vermont, 1903.)

The Nitrogen Cost per lb.



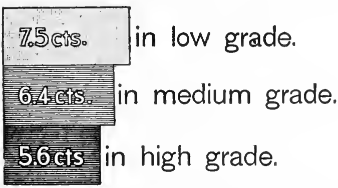
The Nitrogen in Nitrate of Soda, in 1903, cost 15 cents per lb.

The Available Phosphoric Acid Cost per lb.



The Phosphoric Acid in Acid Phosphate, in 1903, cost 4½ cents per lb.

The Actual Potash Cost per lb.



The Actual Potash in Sulphate of Potash, in 1903, cost 5 cents per lb.

Table of Quantities Required per Acre.	Sow (if alone) per Acre
Agrostis stolonifera—See Creeping Bent	2 bushels
" canina—See R. I. Bent	3 bushels
" vulgaris—See Red Top	3 bushels
" " —Fancy	20 lbs.
Alopecurus pratensis—See Meadow Foxtail	3 to 4 bushels
Anthoxanthum odoratum—See Sweet Vernal, peren	3½ bushels
Avena elatior—See Tall Meadow Oat Grass	3 bushels
Arrhenatherum avenaceum—See Tall Meadow Oat Grass	4 to 5 bushels
Awnless Brome Grass	20 to 25 lbs.
Alsike or Hybrid Clover	8 lbs.
Alfalfa Clover	20 to 25 lbs.
Artichokes	8 to 10 bushels
Australian Salt Bush	2 lbs.
Barley	Broadcast, 2 to 2½ bushels; Drilled, 1½ to 2 bushels
Beet Sugar	6 to 8 lbs.
Bermuda Grass	6 lbs.
Bromus inermis—See Awnless Brome Grass	20 to 25 lbs.
Bokhara Clover	10 lbs.
Broom Corn	8 to 10 lbs.
Buckwheat	1 bushel
Beans, Field	Drilled, 1 bushel
Canada Blue Grass	3 bushels
Cynodon dactylon—See Bermuda Grass	6 lbs.
Creeping Bent or Fiorin	2 bushels
Crested Dog's Tail	1½ bushels
Cynosurus cristatus—See Crested Dog's Tail	1½ bushels
Cow Grass—See Mammoth Red Clover	10 to 12 lbs.
Crimson or Carnation—See Scarlet Clover	14 lbs.
Corn, Dent and Flint	8 to 10 qts.
" Fodder	Broadcast, 2 bushels; Drilled, 1 bushel
" Pop	6 to 8 qts.
Carrots	4 lbs.
Cotton	15 lbs.
Dactylis glomerata—See Orchard Grass	3 bushels
Douras	8 to 10 lbs.
English Blue Grass—See Meadow Fescue	2½ bushels
" or Perennial Rye Grass	2½ to 3 bushels
Festuca elatior—See Tall Meadow Fescue	2½ bushels
" heterophylla—See Various Leaved Fescue	3 bushels
" ovina—See Sheep's Fescue	2½ bushels
" " tenuifolia—See Fine Leaved Sheep's Fescue	3 bushels
" pratensis—See Meadow Fescue	2½ bushels
" rubra—See Red Fescue	2½ bushels
" duriuscula—See Hard Fescue	2½ bushels
Fine Leaved Sheep's Fescue	3 bushels
Flax Seed	½ to ¾ bushels
Fiorin—See Creeping Bent	2 bushels
Grasses, Permanent Pasture Mixtures	3 bushels
" " " Clover for above	10 lbs.
" Renovating Mixture	1 bushel
" Lawn	5 bushels
Herd's Grass (of the South)—See Red Top	3 bushels
" " (of the North)—See Timothy	½ to 1 bushel
Hungarian Grass—See Hungarian Millet	1 bushel
Hard Fescue	2½ bushels
Italian Rye Grass	3 bushels
June Grass—See Kentucky Blue	2 to 3 bushels
" Clover—See Red Clover	10 to 12 lbs.
Japan Clover	14 lbs.
Johnson Grass	1 bushel
Jerusalem Corn	5 lbs.
Kaffir Corn	8 to 10 lbs.
Kentucky Blue Grass	3 bushels

Lupins	2 to 3 bushels
Lolium italicum—See Italian Rye Grass	3 bushels
Lolium perenne—See English Rye Grass	2½ to 3 bushels
Lucerne—See Alfalfa	20 to 25 lbs.
Lespedeza striata—See Japan Clover	14 lbs.
Meadow Foxtail	3 to 4 bushels
" Fescue	2½ bushels
Mammoth or Pea Vine Clover	10 to 12 lbs.
Medicago sativa—See Alfalfa	20 lbs.
Millo Maize—See Douras	8 to 10 lbs.
Millet, German and Hungarian	1 bushel
" Pearl, Egyptian, Cat-Tail or Horse Millet	Drills, 5 to 6 lbs.; Broadcast, 8 lbs.
" Japanese	Drills, 10 lbs. per acre; Broadcast, 15 lbs.
Mangels	6 to 8 lbs.
Melilotus alba—See Bokhara Clover	10 lbs.
Onobrychis sativa—See Sainfoin	3 to 4 bushels
Orchard Grass	3 bushels
Oats	3 bushels
Parsnip	6 lbs.
Poa nemoralis—See Wood Meadow Grass	2 bushels
" pratensis—See Kentucky Blue	2 to 3 bushels
" trivialis—See Rough Stalked Meadow Grass	1½ bushels
" arachnifera—See Texas Blue Grass	6 lbs.
" compressa	3 bushels
Phleum pratense—See Timothy	½ to 1 bushel
Potatoes	12 to 14 bushels
Peas, Field	3 bushels
" Cow	2 bushels
Pea Vine Clover—See Mammoth Clover	10 to 12 lbs.
Perennial Red Clover—See Mammoth Clover	10 to 12 lbs.
Rape, English	2 to 4 lbs.
Red Top	3 bushels
" " Fancy	20 lbs.
Rhode Island Bent	3 bushels
Red or Creeping Fescue	2½ bushels
Rough Stalked Meadow Grass	1½ bushels
Red Clover (Common or June Clover)	10 to 12 lbs.
Reana luxurians—See Teosinte	6 to 8 lbs.
Rye	1½ bushels
Ruta Baga	2 to 3 lbs.
Sorghum Halapense—See Johnson Grass	1 bushel
Sweet Vernal—true perennial	3½ bushels
Sheep's Fescue	2½ bushels
Smooth Stalked Meadow Grass—See Kentucky Blue	2 to 3 bushels
Sweet Clover—See Bokhara Clover	10 lbs.
Scarlet Clover	14 lbs.
Sainfoin	3 to 4 bushels
Sorghums	8 to 10 lbs.
Sugar Beet	6 to 8 lbs.
Sugar Canes	8 to 10 lbs.
Sunflower	4 qts.
Swedish Clover—See Alsike	8 lbs.
Soja Bean	¾ bushel
Texas Blue Grass	6 lbs.
Tall Meadow Oat Grass	4 to 5 bushels
" " Fescue	2½ bushels
Timothy or Herd's Grass of the North	½ to 1 bushel
Trifolium pratense—See Red Clover	10 to 12 lbs.
" " perenne—See Mammoth Clover	10 to 12 lbs.
" repens—See White Clover	8 lbs.
" incarnatum—See Scarlet Clover	14 lbs.
" hybridum—See Alsike Clover	8 lbs.
Toesinte	6 to 8 lbs.
Turnips	2 to 3 lbs.
" Ruta Baga, Russian or Swedish	2 to 3 lbs.
Vetch, Spring (Tares)	2 bushels
" Sand or Winter	1 bushel
Various Leaved Fescue	3 bushels
Wood Meadow Grass	2 bushels
White or Dutch Clover	8 lbs.
Wheat	1½ bushels

REFERENCE TABLE FOR VEGETABLE SEED SOWERS.

KIND OF VEGETABLE	DATES FOR SOWING VICINITY NEW YORK CITY. *North, later; South, earlier. As a general rule, it is pretty safe to allow six days' difference in planting for every hundred miles of latitude.*		BEST TEMPERATURE TO GERMINATE	DAYS NEEDED TO GERMINATE.	READY FOR USE FROM SEED SOWN	DISTANCE TABLE.		SEED REQUIRED FOR 100 FEET OF DRILL.	SEED REQUIRED FOR AN ACRE
	UNDER GLASS.	OPEN GROUND.				APART IN ROWS.	ROWS APART		
Asparagus, Seeds		April and May	60°	20 to 28	3 to 4 years			2 oz.	4 to 5 lbs.
“ Roots		April				1 ft.	2 ft.		
Beans, Dwarf		May 15th to Aug. 1st.	75°	6 to 10	45 to 75 days	3 in.	2 ft.	1 qt.	1 bush.
“ Pole		May 15th to June 15th	80°	6 to 10	65 to 100 “	3 ft.	4 ft.		10 to 12 qts.
“ Lima		“ “	80°	6 to 10	65 to 90 “	3 ft.	4 ft.		10 to 12 qts.
Beets		April to August	60°	7 to 10	60 to 75 “	4 in.	1 ft.	2 oz.	5 to 6 lbs.
Borecole (Kale) for spring use		August and September	70°	6 to 10	85 to 120 “	2 ft.	2½ ft.	¾ oz.	1 to 2 lbs.
“ “ for fall use		June	70°	6 to 10	85 to 120 “	2 ft.	2½ ft.	¾ oz.	1 to 2 lbs.
Brussels Sprouts		April to July	70°	6 to 10	100 to 120 “	1½ ft.	2½ ft.		1 lb.
Cabbage, Early	February	April	70°	6 to 10	100 to 125 “	1½ ft.	2 ft.		½ lb.
“ Late		May and June	70°	6 to 10	120 to 180 “	2½ ft.	2½ ft.		½ lb.
Carrot, Early		April	60°	10 to 15	65 to 85 “	4 in.	1½ ft.	1 oz.	4 lbs.
“ Late		May to July	60°	10 to 15	100 to 120 “	5 in.	2 ft.	1 oz.	4 lbs.
Cauliflower, Early	February	April	70°	6 to 10	100 to 115 “	1½ ft.	2½ ft.		½ lb.
“ Late		May and June	70°	6 to 10	100 to 135 “	2 ft.	3 ft.		½ lb.
Celery		April	60°	12 to 20	125 to 150 “	6 in.	3 to 5 ft.	1 oz.	1 lb.
Corn, Sugar		May 10th to July 10th.	75°	8 to 10	60 to 100 “	3 ft.	4 ft.		¼ bush.
Cucumber		May 15th to July 15th.	80°	6 to 8	60 to 85 “	4 ft.	4 ft.		2 to 3 lbs.
Egg Plant	March		80°	10 to 14	125 to 160 “	2½ ft.	2½ ft.		½ lb.
Endive	February	April to August	60°	6 to 10	75 to 100 “	1 ft.	1 ft.	1 oz.	3 lbs.
Kohl Rabi		April to July	70°	6 to 8	65 to 85 “	1 ft.	2 ft.		½ lb.
Leek	February	April and May	60°	6 to 10	120 to 160 “	6 in.	1½ ft.	1 oz.	5 to 6 lbs.
Lettuce	February	April to August	60°	6 to 10	75 to 100 “	1 ft.	1 ft.	1 oz.	2 to 3 lbs.
Melon, Musk		May 15th to June 15th	80°	6 to 10	90 to 120 “	4 ft.	4 ft.		2 to 3 lbs.
“ Water		“ “	80°	8 to 12	100 to 125 “	8 ft.	8 ft.		4 to 5 lbs.
Onion Seed	February	April and May	60°	6 to 10	120 to 150 “	3 in.	1 ft.	1 oz.	5 to 6 lbs.
“ Sets		“ “				3 in.	1 ft.	3 pts.	
Parsley		“ “	60°	18 to 24	90 to 100 “	4 in.	1 ft.	¾ oz.	5 to 6 lbs.
Parsnip		April	60°	12 to 18	100 to 150 “	6 in.	1 ft.	½ oz.	5 to 6 lbs.
Peas, Wrinkled		April 15th to July 1st.	70°	5 to 10	50 to 75 “	2 in.	2 to 4 ft.	1 qt.	2 to 3 bush.
“ Smooth		April 1st to Aug. 1st.	65°	5 to 10	50 to 65 “	2 in.	2 to 4 ft.	1 qt.	2 to 3 bush.
Pepper	March		80°	10 to 14	135 to 150 “	2 ft.	2½ ft.		½ lb.
Potatoes		April 15th to June 1st.	70°	15 to 25	75 to 100 “	10 in.	2½ ft.		10 to 12 bush.
Pumpkins		May 20th to June 20th	80°	6 to 10	100 to 125 “	8 ft.	8 ft.		4 to 5 lbs.
Radish		April 1st to Sept. 15th.	60°	4 to 6	25 to 50 “	2 to 4 in.	1 to 1½ ft.	1 oz.	9 to 10 lbs.
Salsify		April and May	60°	8 to 12	125 to 160 “	6 in.	1½ ft.	1½ oz.	8 to 10 lbs.
Spinach		April to Sept. 15th.	60°	6 to 12	60 to 75 “	4 in.	1 to 1½ ft.	1 oz.	10 to 12 lbs.
Squash, Summer		May 15th to July 1st.	80°	6 to 10	60 to 75 “	4 ft.	4 ft.		3 to 4 lbs.
“ Winter		May 20th to June 20th	80°	6 to 10	100 to 125 “	8 ft.	8 ft.		3 to 4 lbs.
Tomato	Feb. and Mar.	June 1st	80°	6 to 10	125 to 150 “	3 ft.	3 ft.		¼ lb.
Turnip		April to September	70°	4 to 7	60 to 75 “	6 in.	1 to 1½ ft.	¾ oz.	1 to 2 lbs.

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